EXPEDITION PROGRAMME No. 90

RV POLARSTERN

ANT-XXIX/1
27 October 2012 - 27 November 2012
Bremerhaven - Cape Town

ANT-XXIX/2
30 November 2012 - 18 January 2013
Cape Town - Punta Arenas

ANT-XXIX/3
20 January 2013 - 19 March 2013
Punta Arenas - Punta Arenas

Coordinator
Dr. Rainer Knust

Chief Scientists

ANT-XXIX/1: PD Dr. Holger Auel
ANT-XXIX/2: Dr. Olaf Boebel
ANT-XXIX/3: Prof. Dr. Julian Gutt

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ANT-XXIX/1

27 October 2012 - 27 November 2012

Bremerhaven - Cape Town

Chief Scientist
PD. Dr.Holger Auel

Coordinator
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1. ÜBERBLICK UND FAHRTVERLAUF

Holger Auel
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Mit der Überführungsreise ANT-XXIX/1 vom 27. Oktober bis 27. November 2012 von Bremerhaven nach Kapstadt beginnt für *Polarstern* im Jahr ihres dreißigjährigen Betriebsjubiläums eine ungewöhnlich lange Forschungskampagne auf der Südhalbkugel. Das Schiff wird in der Antarktis überwintern und erst nach 1,5 Jahren wieder in den Heimathafen Bremerhaven zurückkehren.

Auch die für die Überfahrt geplanten wissenschaftlichen Arbeiten weichen stark vom Standardprogramm ab und enthalten mit der internationalen EUROPA-Summer School eine echte Premiere. Erstmals nutzt eine große Gruppe von 28 internationalen Doktorandinnen und Doktoranden sowie Master-Studierenden unter der Betreuung von 11 Wissenschaftlern und Dozenten von insgesamt 11 verschiedenen Universitäten und Forschungseinrichtungen *Polarstern* für eine interdisziplinäre Trainingsinitiative. An etwa 20 Stationen entlang der Fahrtroute werden Daten und Proben gesammelt für ein interdisziplinäres Forschungs- und Ausbildungsprogramm zum Thema „Pelagische Biodiversität des Atlantischen Ozeans“. Den Studierenden wird dabei die einzigartige Gelegenheit geboten, modernste Methoden der Meeresforschung direkt auf See kennen zu lernen und praktisch anzuwenden.

Im Rahmen des OCEANET-Programms werden en route Atmosphärenmessungen durchgeführt, um die Datengrundlage für Klimamodelle zur Verfügung zu stellen und diese zu überprüfen. Schwerpunkte dieses Projekts sind die Strahlungsbilanz an der Erdoberfläche, die Partikel- und Aerosolzusammensetzung in der Atmosphäre sowie die Wolkenbildung. Ein von DESY durchgeführtes Projekt misst kosmische Teilchen und deren Interaktionen mit der Erdatmosphäre. Dazu wird ein neuer Muon-Detektor/Neutronen-Monitor für kontinuierliche Messungen auf *Polarstern* installiert.

Für ein weiteres Projekt, das sich mit der Identifizierung der Fortpflanzungsgebiete antarktischer Bartenwale im subtropischen Atlantik beschäftigt, soll die Tiefseeverankerung AWI 247-2, verankert auf 20°57.8'S 005°58.6'E vor Namibia nahe des Walfischrückens, aufgenommen und neu ausgebracht werden. Die Verankerung trägt einen passiv-akustischen Rekorder, Sonovault, um die Anwesenheit von Bartenwalen in ihren vermutlichen, bislang jedoch weitgehend unbestätigten Fortpflanzungsgebieten zu untersuchen.

Vervollständig werden die Arbeiten an Bord durch die Installation, Einrichtung bzw. Kalibrierung einer Reihe von wissenschaftlichen Geräten für die folgende lange Antarktis-Forschungskampagne. Dazu gehören u.a. die Kalibrierung des Hydrosweep-Echolots für die Bathymetrie, die Kalibrierung des EK60-Mehrfrequenz-Echolots für Fischerei- und Zooplanktonuntersuchungen sowie die Einrichtung und Test einer neuen Radiosonden-anlage für Wetterballons.

SUMMARY AND ITINERARY

Holger Auel
BreMarE – Bremen Marine Ecology, University of Bremen

The transfer voyage ANT-XXIX/1 from Bremerhaven to Cape Town between 27 October and 27 November 2012 will mark the start of an exceptional long research campaign on the southern hemisphere in the year of *Polarstern's* 30th anniversary. The vessel will overwinter in Antarctica and return to its homeport Bremerhaven after 1.5 years.

The scientific activities planned for the transfer cruise also strongly differ from the standard programme. With the international EUROPA Summer School, they include a real premiere. For the first time, a big group of 28 international doctoral and master students under the supervision of 11 scientists and lecturers from 11 different universities and research institutions will use *Polarstern* for an interdisciplinary training initiative. At about 20 stations along the cruise track, data and samples will be collected for an interdisciplinary research and education programme focussing on the "Pelagic Biodiversity of the Atlantic Ocean". Students will have the unique opportunity to learn and apply state-of-the-art methods in marine research directly at sea for hands-on practical training.

In the framework of the OCEANET programme, atmospheric measurements will be conducted en route to provide a data basis and ground-truthing for climate models. Major focus of this project is the radiation balance at the Earth's surface, the particle and aerosol composition in the atmosphere and cloud formation. Another project managed by DESY measures cosmic particles and their interactions with the Earth's atmosphere. For this purpose, a new muon detector/neutron monitor for continuous measurements will be installed on *Polarstern*.

In order to identify and confirm the breeding grounds of Antarctic baleen whales in the subtropical Atlantic Ocean, the deep-sea mooring AWI 247-1, deployed at 20°57.8'S 005°58.6'E off Namibia near the Walvis Ridge, will be recovered and re-deployed. The mooring hosts a passive acoustic monitoring device, SonoVault, to verify the presence of large mysticete species on their proposed, yet largely unconfirmed, breeding grounds.

Work onboard will be completed by the installation, configuration and calibration of a series of scientific equipment intended for use during the following long Antarctic research campaign. This task includes the calibration of the Hydrosweep multi-beam echosounder for bathymetry, the calibration of the EK60 multi-frequency echosounder for fisheries and zooplankton studies as well as the installation and test of new radiosonde equipment for weather balloons.

2. EUROPA – EUROPEAN UNIVERSITIES & RESEARCH ONBOARD POLARSTERN IN THE ATLANTIC (S-589)

H. Auel , L. Teuber , M. Bode , M. Giunio , C. Albrecht , T. Schwenke (Uni HB), S. Schiel, H.-J. Hirche, K. Schmidt , M. Ginzburg (AWI),J. Harder (MPI HB), E. Garcia Vazquez (Uni Oviedo), E. Morote (Uni Algarve), A. Zaiko (Uni Klaipeda), M. Kochzius, F. Dehairs, L. Páiz-Medina (VUB),M. Wolowicz (Uni Gdansk), F. Shillington (UCT), M. Zure (Uni HB/MPI HB), J. Smith (Uni HB/AWI), A. Sotillo (Uni Gent), L. Vansteenbrugge (Uni Gent/ILVO), M. Rembauville (UPMC), J. Schmidt-Petersen , A. Neuhaus , A. Adamopoulou , M. Papadatou , L. Brunelli , H. van de Sande , R. Buonomo , C. Gil Fernández , C. Maréchal , C. Hörterer , S. Jungblut , D. Ribičić , A. Islam , F. Rodrigues , L. Mevenkamp (EMBC)
K. Valentin (AWI, not on board)

Objectives

For the first time, *Polarstern* will be used for an international training initiative with 39 professors, lecturers, doctoral candidates and M.Sc. students from 11 different universities and research institutions in the framework of the EU-funded MARES and EMBC science and education projects. The primary objective of the EUROPA cruise is training of Ph.D. candidates and master students in state-of-the-art methods in marine research. Students shall learn how to collect data and samples at sea, how to process, analyse and interpret the results. The cruise will be a unique opportunity for hands-on training in an interdisciplinary and international setting. Research and training will focus on the pelagic biodiversity of Atlantic Ocean including physical oceanography, biogeochemistry, marine microbiology, phytoplankton studies, ecology and ecophysiology of zooplankton, molecular genetics, and seabird and marine mammal surveys. The close co-operation of scientists from different partner universities on board will strengthen international collaboration in higher education and marine research.

Background information on the MARES programme

The ERASMUS MUNDUS Joint Doctoral Programme in Marine Ecosystem Health and Conservation (MARES; http://www.mares-eu.org) has been selected for funding by the European Union in 2010 and officially started in academic year 2011/2012. MARES is offered by a consortium of 24 international partners including 11 universities (10 from Europe, 1 Australian), six marine research institutions, four enterprises and three non-governmental organisations. The programme provides advanced, doctoral-level training and integrated research in six research fields relevant to the health and conservation status of marine ecosystems, i.e. (i) Future Oceans: temperature changes - hypoxia – acidification, (ii) Understanding biodiversity effects on the functioning of marine ecosystems, (iii) Biological invasions, (iv) Natural Resources: overexploitation, fisheries and aquaculture, (v) Ocean noise pollution, and (vi) Habitat loss, urban development, coastal infrastructures and Marine Spatial Planning.

Each doctoral project is offered by at least two MARES partner institutions and requires Ph.D. candidates to conduct research in two European countries. Besides research, candidates participate in advanced scientific and transferable skills training courses as well as in annual scientific networking events. MARES awards joint doctoral degrees in Marine Sciences to candidates who successfully complete the programme.

Background information on the EMBC programme

The ERASMUS MUNDUS M.Sc. programme in Marine Biodiversity and Conservation (EMBC; http://embc.marbef.org) has been developed as the capacity building component of the previous European Network of Excellence MarBEF (Marine Biodiversity and Ecosystem Functioning). A consortium of six European universities with a strong background in marine research and education (University of Ghent, Belgium; University of Bremen, Germany; University of the Algarve, Faro, Portugal; University of Oviedo, Spain; University of Paris 6 with its field stations in Roscoff, Banyuls, and Villefranche sur mer, France; University of Klaipeda, Lithuania) join their expertise and infrastructure to offer a unique opportunity for state-of-the-art training in marine sciences. In a very challenging competition in 2008, the master programme was selected for funding by the European Commission in its ERASMUS MUNDUS programme. The European Union provides scholarships for students to participate in the programme. The number of students starting each year has been continuously growing from 32 students in the first year 2008 via 46 in 2009 to 51 in 2010, proving the attractiveness of the education programme. Students have to acquire knowledge and skills in three different thematic modules, i.e. (i) Understanding marine biodiversity, (ii) Toolbox for studying marine biodiversity, and (iii) Conservation and restoration of marine biodiversity.

EMBC students choose to study the first year either in Bremen, Gent or Faro, before they move to Paris, Oviedo or Klaipeda for the third term. The master theses can be prepared at either one of the six partner universities or at one of over 80 MarBEF institutes all over Europe, including AWI and MPI in Bremen. Because of this de-centralised structure of the study programme, the European Union puts great emphasis on joint training events such as the EUROPA cruise as opportunities for students from different universities to meet in one place, interact with each other and actively participate in state-of-the-art marine research.

Work at sea

Ph.D. and master candidates will work in small teams on eleven different research projects under the supervision of the participating scientists. About 20 stations along the cruise track throughout the Atlantic Ocean will be sampled with CTD/Rosette, MultiNet, Manta Trawl, Bongo Net, and LOKI. Research topics include:

1. Physical oceanography: Water mass structure and circulation in the Atlantic Ocean

CTD casts will be conducted at all stations to record temperature and salinity profiles, and if profiles of oxygen concentration and chlorophyll concentration/fluorescence. Students will use the data to plot T/S diagrams and identify different water masses. Students will learn about the thermo-haline circulation/meridional overturn circulation, water mass formation and modification, the importance of deep water formation by deep convection and the extension of deep water throughout the Atlantic Ocean. Zooplankton species composition will be related to hydrographic data in order to identify potential indicator species for certain water masses.

2. Biodiversity and Activity of Microbial Biofilms in Niches in the Ocean (BAMBINO)

Microbial biodiversity and activity in the pelagial of the oceans is intensively studied for free-living bacteria, mainly by cultivation-independent approaches. Little attention has been given to microbes living attached to particles or higher organisms as well as of microbes living in the digestive tracts. On the EUROPA expedition, we will sample for molecular marker analyses and perform isolation experiments as well as activity measurements. Marine microbiology has progressed rapidly in an understanding of the free-living microbes in the ocean. But behind the frontier, the field of fish microbiology and the microbiology of particles awaits exploitation. The EUROPA expedition creates a unique transdisciplinary team to study

pelagic communities and integrates as one of the first cruises molecular approaches to microorganisms and eukaryotes. Water samples from the CTD will be taken and frozen for the analysis of DOM. Water samples from the CTD will be filtered and the biomass of the filters will be frozen for molecular analyses. Cultures will be inoculated. In cooperation with the zoologists, samples of specimens will be selected for subsampling of microbes in the digestive tract and on the surface. Non-natural particles will be sampled for the analysis of microbial biofilms. Onboard experiments with zooplankton will provide fresh faecal pellets for the analyses of microbial biodiversity.

3. Phytoplankton: Latitudinal trends in primary production and chlorophyll concentration along the transect.

Students will take regular samples from the CTD rosette to filter phytoplankton and measure chlorophyll concentration. Measurements will be compared and correlated to fluorescence profiles provided by the CTD. In addition, primary production shall be measured, the influence of phytoplankton on biogeochemical cycles will be studied, and molecular genetic studies will be conducted on phytoplankton species.

4. Mesozooplankton biodiversity: Latitudinal and vertical trends in mesozooplankton species composition throughout the Atlantic Ocean.

Mesozooplankton will be sampled by stratified vertical hauls down to 800 m with opening and closing nets (Hydro-Bios Multinet Maxi and Midi). Samples will be analysed immediately on board for zooplankton abundance, vertical distribution, species composition and biodiversity in different oceanographic regimes along the latitudinal transect. Specimens will be sorted out for molecular genetic studies and experiments on board. The remains of the samples will be preserved in ethanol and/or formaldehyde. If possible, some of the samples will be collected at night in order to study diel vertical migration (DVM) patterns. The effects of DVM on pelagic secondary production and pelago-benthic coupling processes (biological pump) will be assessed and discussed. Latitudinal gradients of zooplankton biodiversity shall be monitored and explained in the context of trends in marine primary production. Vertical and regional changes in the dominant feeding behaviour and dietary composition of zooplankton species will be analysed.

5. High resolution zooplankton distribution with LOKI.

Zooplankton plays a key role in the transfer of organic matter from primary producers to higher trophic levels and in the global carbon cycle. However, common sampling gear, like towed plankton nets, have shortcomings like low resolution, intrinsic depth integration and time consuming sample analysis, which limit studies on adequate temporal and spatial scales.

During the cruise, high-resolution studies of the vertical and horizontal distribution of zooplankton and its relation to environmental factors will be studied using LOKI, a newly developed optical system for *in-situ* imaging of zooplankton and particles. LOKI consists of a control module for pre-processing and logging camera (4 megapixel GigE) and environmental sensor data, and an image head with a specific illumination system to optimize image resolution. Imaging runs with 15 fps at full resolution. Frames trigger a high power LED flash unit allowing exposure times <100 µs. Each image frame is processed in real time and Areas Of Interest (AOI) are extracted in the underwater unit. Time stamps are assigned to every AOI and allow association with recorded environmental parameters (pressure, temperature, salinity, oxygen, fluorescence).

Deployment in various water masses during the cruise, from oligotrophic to highly productive regions, will allow to study the vertical structure of the habitats of different zooplankton communities in relation to the respective environmental conditions. Of special interest are the oxygen minimum zones off northwest and southwest Africa, where a strong oxycline separates oxygenated surface waters from hypoxic deeper layers.

6. Temperature-dependence of zooplankton respiration.

In the temperature-controlled containers on board, respiration measurements will be conducted with dominant zooplankton species in order to determine the temperature-dependence of metabolic activity (Q10 ratio) and discuss its influence on vertical migrations and depth of occurrence in relation to depth profiles of temperature provided by CTD casts. Correlations of individual respiration rate and mass-specific respiration rate versus body mass will be established. The nutritional demand / maximum ingestion rate will be calculated based on the results of the respiration rates and an energy budget approach. Respiration measurements will be conducted under simulated in situ conditions by Winkler titration, oxygen electrodes and oxygen optodes in order to compare the different measurement principles. Usually 10 to 20 individuals will be incubated in gas-tight bottles filled with filtered and oxygenated sea water for several hours. The decrease in oxygen concentration will be monitored in comparison to animal-free controls to compensate for microbial oxygen consumption.

7. Energy budget of dominant species of mesozooplankton.

The ingestion of dominant zooplankton species will be measured in feeding experiments. Herbivorous species will be offered a phytoplankton solution as food and the decrease in algal and chlorophyll concentration will be monitored either by microscopic counts or flourometry. Carnivorous species will be offered a selection of prey in appropriate size classes and the number of prey items consumed per unit of time will be measured. In addition, for some species the amount of energy to be spent for reproduction will be determined by experimental measurements of egg production. Based on the empirical results of the feeding and egg production experiments and respiration measurements (provided by the partner project), energy budgets will be established for certain dominant species of zooplankton, for instance some copepods. The data will be used to calculate assimilation efficiencies and to estimate the amounts of energy available for growth and reproduction.

8. Macrozooplankton & ichthyoplankton biodiversity: Latitudinal trends in species composition throughout the Atlantic Ocean.

Latitudinal trends in macrozooplankton and ichthyoplankton abundance, species composition and biodiversity throughout the Atlantic Ocean will be studied. Samples for these analyses will be collected by towed Bongo net hauls. Samples will be processed in a similar way as described for mesozooplankton. Special focus will be given to ichthyoplankton and pteropods.

9. Molecular Genetics: DNA barcoding.

Individuals identified to species level will be handed over to the geneticist team on board for DNA extraction and barcoding. DNA sequence data will be submitted to GenBank and CmarZ data bases.

10. Pelagic top-predators: Abundance and species composition of seabirds and cetaceans along the cruise track.

Students will carry out a continuous sighting survey for seabirds and cetaceans from the bridge and/or monkey island in order to record changes in abundance and/or species composition and to identify hot spots of top-predator abundance. They will learn about different concepts and strategies of line and band transect surveys. Results will be related to hydrographic and bathymetric data as well as to information on primary productivity and zooplankton biomass in order to explain trends.

11. Biological invasions via ballast water.

The transfer and viability of planktonic organisms in the ballast water of the vessel will be studied. This will include monitoring of abundance and diversity of planktonic organisms in ballast water tanks during the journey related to the abiotic conditions within the tanks. The final goal is to assess the potential risk of alien species introduction via ballast water transfer from European to African coastal waters taking into account the biological traits of the surviving organisms and ecological features of the recipient area.

3. OCEANET - AUTONOMOUS MEASUREMENT PLATFORMS FOR ENERGY AND MATERIAL EXCHANGE BETWEEN OCEAN AND ATMOSPHERE: ATMOSPHERE (S-576)

R. Engelmann, T. Kanitz, M. Merkel, Z. Wu (IfT, to Las Palmas), M. Brückner, M. Leistert (LIM), S. Huang (IfT),
A. Macke (IfT, not on board), D. Althausen (not on board), A. Wiedensohler (not on board), K. Bumke (not on board)

Objectives

a) Radiation & microwave remote sensing

The net radiation budget at the surface is the driving force for most physical processes in the climate system. It is mainly determined by the complex spatial distribution of humidity, temperature and condensates in the atmosphere. The project aims at observing both the radiation budget and the state of the cloudy atmosphere as accurate as possible to provide realistic atmosphere-radiation relationships for use in climate models and in remote sensing. While similar experiments have been performed from land stations, only few data from measurements over ocean areas exist. The present project is part of the “Meridional Ocean Radiation Experiment” MORE which uses Atlantic transfers of various research vessels for the combined measurements of the atmospheric state since 2004. The main project behind this cruise is the WGL-PAKT Initiative OCEANET.

A multichannel microwave radiometer will be applied to continuously retrieve temperature and humidity profiles as well as cloud liquid water path over the ocean. Time series of these profiles will show small scale atmospheric structures as well as the effects of the mean state of the atmosphere and its variability on the co-located measurements of the downwelling shortwave and longwave radiation. The atmospheric profiles will also be used to validate the satellite based profiles from the IASI instrument onboard the new European polar orbiting satellite MetOp. Atmospheric aerosol optical thickness will be measured by means of hand held sun photometer and spectral solar radiometer. Most instruments will be integrated in the new container-based atmosphere observatory.

b) Lidar measurements

Since more than 15 years IfT developes and operates an advanced lidar systems in order to study optical and microphysical aerosol properties in the troposphere. The system PollyXT, a semi-autonomous multiwavelength polarization Raman lidar will be operated inside a container, together with the radiation and microwave sensing equipment. The lidar is able to measure independently profiles of particle backscatter at three wavelengths and extinction at two wavelengths, which allows identifying particle type, size, and concentration. Additionally particle depolarisation is measured in order to discriminate between spherical and non-spherical particles, e.g. biomass-burning smoke vs. mineral dust or water clouds vs. ice clouds. Recently the lidar has been equipped with a measurement channel for atmospheric water-vapour, too. The data are used to characterize long-range transport of aerosol and identify pollution. The determined height-resolved aerosol extinction completes the radiation measurements. In this way, the radiative influence of single lofted aerosol or cloud layers can be calculated with radiation-transport models.

c) Aerosol in-situ measurements

The portfolio of the Aerosol Group at IfT includes the *in-situ* characterisation of atmospheric aerosols in urban as well as remote background atmospheres, the characterisation of regional and urban air quality, the examination of hygroscopic particle properties, the measurement and simulation of *in-situ* aerosol optical properties, the investigation of atmospheric transport processes, and the development of new and improved instruments for physical aerosol characterisation. Onboard *Polarstern* all measurements will be conducted inside a temperature-controlled container laboratory, and focus on the particle characterisation using high-end scientific instruments in order to study:

- physical aerosol properties using an Aerodynamic Sizer (APS) and Tandem Differential Mobility Analyser (TDMPS) for particle number size distributions from 3 nm to 10 µm, and a Humidifying Differential Mobility Particle Sizer (HDMPS) for the hygroscopic growth of the particles;
- optical properties using a nephelometer and an absorption photometer to measure the particle light scattering and absorption coefficients, respectively; and
- particle chemical composition using a High Resolution Time of Flight Aerosol Mass Spectrometer (HR-ToFAMS) for the non-refractory PM1.

Work at sea

Upon departure both container-based atmosphere observatories will be installed on the observation deck of *Polarstern*. Most measurements will be performed underway and continuously. The following individual instruments are combined:

1) Multichannel microwave radiometer HATRPO. The instrument requires occasional calibrations with liquid nitrogen as well as tipp-calibrations under calm sea and homogeneous atmospheric conditions.
2) Whole sky imager for cloud structure measurements
3) Multiwavelength polarization Raman lidar PollyXT
4) Handheld sun photometer (Microtops) for aerosol and cloud optical thickness
5) *in-situ* aerosol measurements

Expected results

1) 2d structure of the clear sky atmosphere and corresponding net radiation budget.
2) Horizontal structure of the cloud water path and its effect on the downwelling shortwave and longwave radiation

3) Vertical structure of temperature and humidity as well as its variability for validation of satellite products
4) Vertical profiles of tropospheric aerosols and their effect on radiation
5) Near-surface aerosol size distributions and their physical and chemical compositions

4. ATLANTIC BREEDING GROUNDS OF MYSTICETES OF THE SOUTHERN HEMISPHERE (S-604)

H. Sander (OPTIMARE)
O. Boebel, I. van Opzeeland, M. Monsees (AWI, not on board)

Objectives

The large baleen whales of the Southern Hemisphere are migratory inhabitants of the open ocean and hence are not easily accessible for direct observation. They are thought to migrate between summer feeding grounds near Antarctica and winter breeding grounds in the subtropical ocean. However, knowledge on summer and particularly winter distribution of true (or Antarctic) blue (*Balaenoptera musculus intermedia*), fin (*Balaenoptera physalus*), sei (*Balaenoptera borealis*) and Antarctic minke whales (*Balaenoptera bonaerensis*) is sparse and mainly based on historic catch data and the Discovery tagging program. The resulting uncertainty is clearly reflected even in contemporary distribution maps. Interestingly, in the southern Atlantic, the evidence at hand points to similar summer breeding grounds for all four species, namely the northern Angola Basin for Antarctic minke whales (7°S 3°W), the central Angola Basin for sei whales (15°S 5°W), and the southern Angola Basin for fin whales (21°S 1°E) and for true (or Antarctic) blue whales (22°S 7°E).

Given that many of the baleen whale species in the Southern Hemisphere have been severely depleted by commercial whaling, knowledge of the locations of their breeding grounds and an improved understanding of migratory routes and behaviour of these species is important for conservation measures to aid the recovery of these populations. All species are known to vocalize on the breeding grounds, rendering passive acoustic monitoring techniques therefore a valuable tool to study large baleen whale breeding ground distribution patterns. For blue and fin whales, geographic variation in vocalizations even allows identification of different (breeding) populations. Such information may provide insight into the extent to which each baleen whale species is grouped into separate localities on the breeding grounds.

Autonomous recording devices are battery-powered and record and store acoustic data internally. Dependent on data storage capacity of the device, recording bandwidth and sampling regime, recordings can be obtained over extended periods of time, in some cases up to several years. Best results are obtained when deployed in the so-called SOFAR channel, a sound-duct which is located at about 1,000 m depth in the subtropical ocean.

Work at sea

A single oceanographic mooring, AWI 247-2 deployed at 20°57.8'S 005°58.6'E in the southern Angola Basin, hosting a passive acoustic recorder (SonoVault) and a recording CTD will be recovered (Figure 4.2) and re-deployed (Figure 5.3) for the period of one year (Figure 4.1). The recordings will be conducted simultaneously with similar recordings in the Antarctic summer feeding grounds. The recorder is deployed at a depth of nominally 900 m, the core of the SOFAR channel, where detections ranges are expected to exceed the order

of 200 km. This allows monitoring both the suspected fin and blue whale breeding grounds with only a single mooring. The mooring shall be recovered in 2014, preferably during a consecutive *Polarstern* transit cruise.

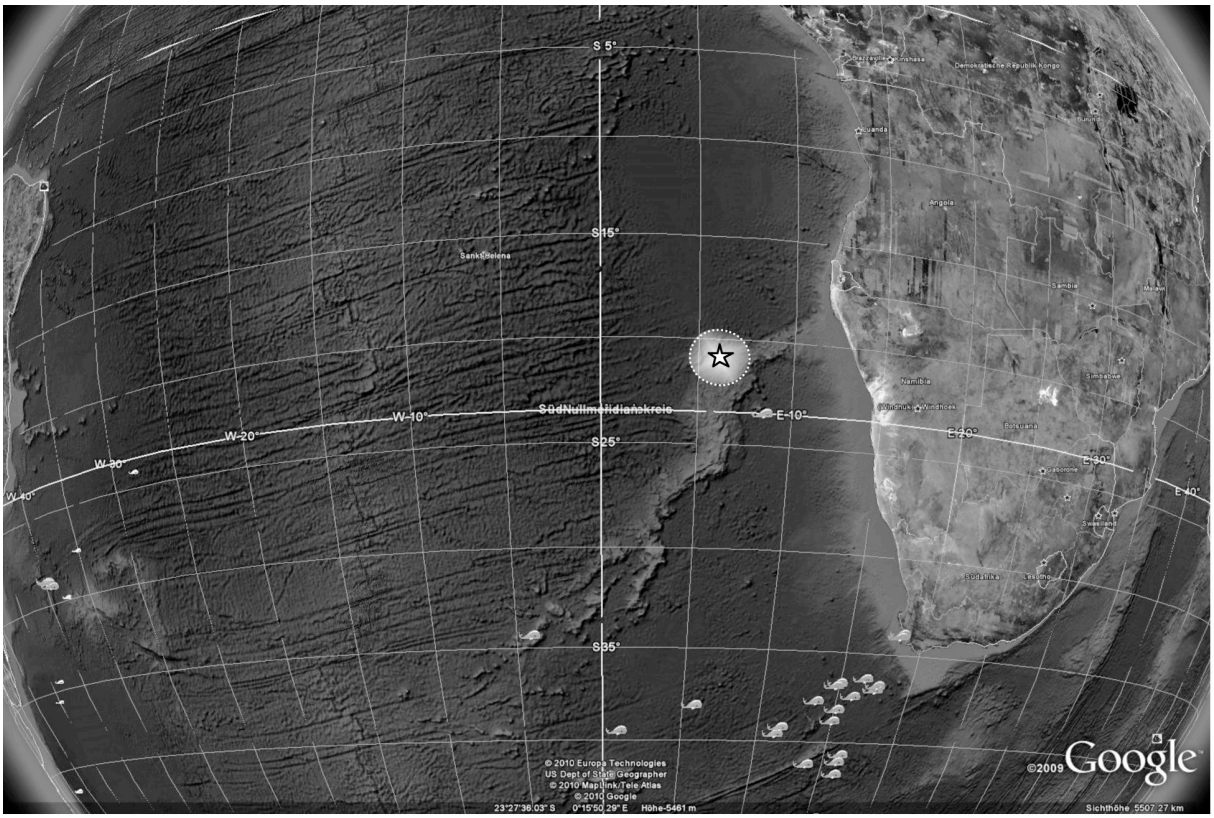

Fig. 4.1: Mooring position at 20°57.8'S 005°58.6'E (white star) close to the northern edge of Walvis Ridge. The white circle indicates a (minimum) listening circle of 200 km. Whale symbols indicate positions of whale sightings from onboard Polarstern.

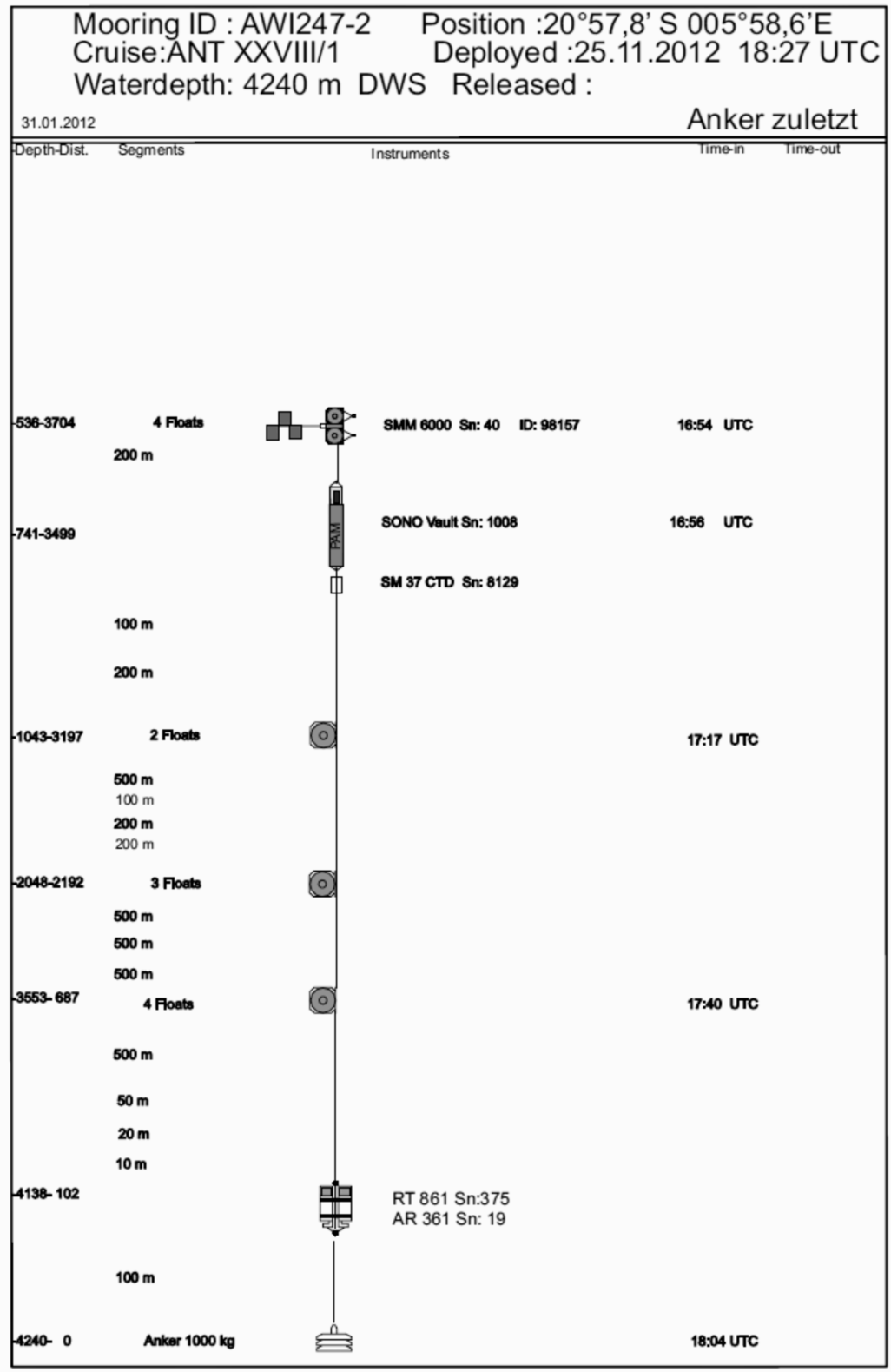

Fig. 4.2: Schematic of mooring AWI 247-2 (to be recovered).

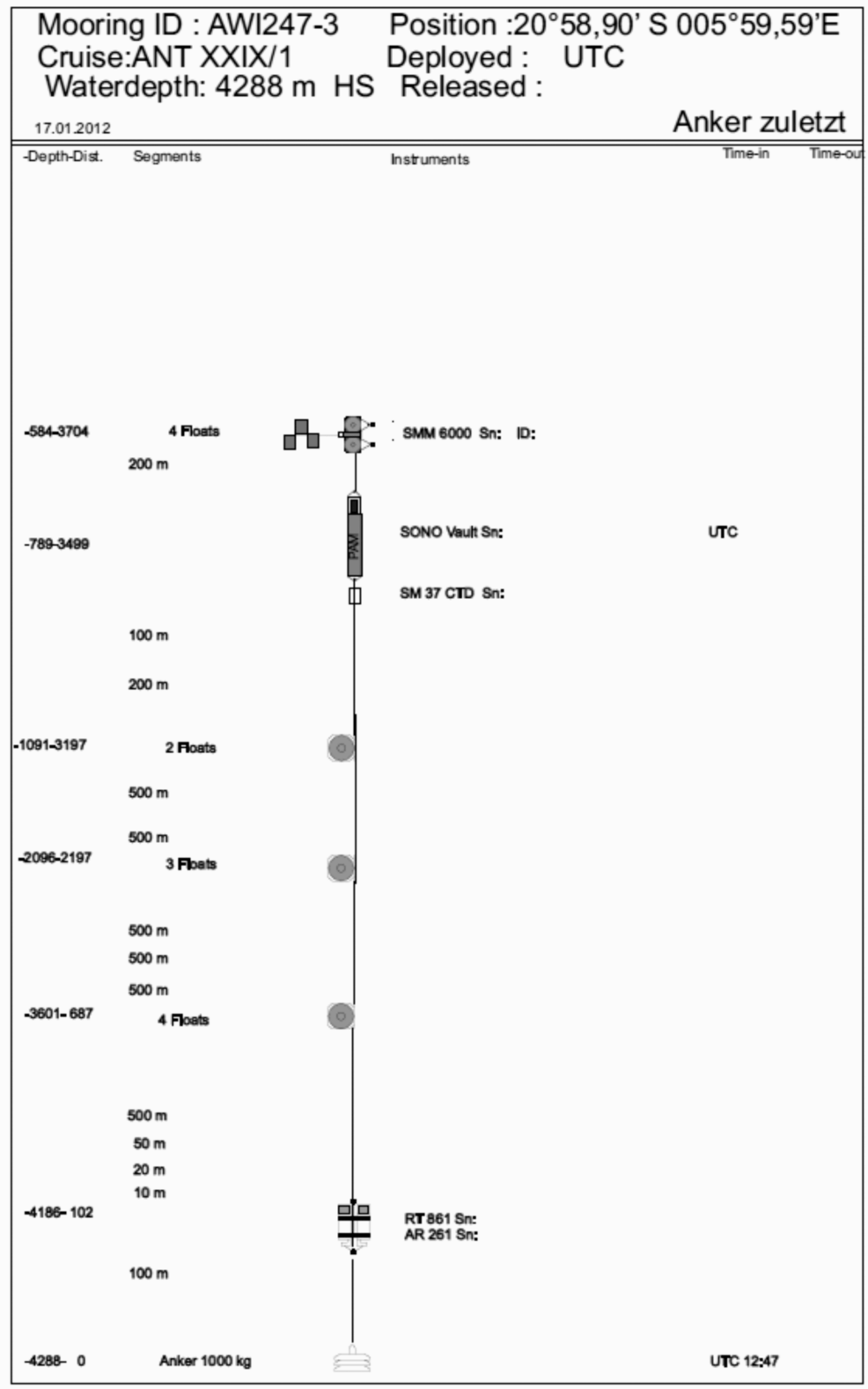

Fig. 4.3: Schematic of mooring AWI 247-3 (to be deployed).

5. MEASUREMENT OF COSMIC PARTICLES (S-607)

C. Schwerdt (DESY), M. Walter (DESY, not on board)

Objectives

Goal of the project is the measurement of cosmic particles in dependence on different parameters as air pressure, temperature in atmosphere and latitude.

At sea level we measure mostly muons. Muons are decay products of secondarys produced by primary cosmic particles which are continuously raining down on our planet from space. Primary cosmic rays are charged particles, in particular protons, but also helium, heavier elements and electrons, and come from the sun or from galactic and extragalactic sources. Reaching the earth, they collide and interact with the atoms of the upper atmosphere in heights of 20 to 30 km. Thereby new particles are produced which can again collide with the atoms in the air or they can decay. Decay products are lighter charged particles, like muons (generated in heights of 15 to 25 km) and electrons, or uncharged neutrinos and gamma-rays.

The sun is a source of relatively low energy protons. Since the sun's activity will reach its maximum in 2013/14, an increase of eruptions will lead to higher particle radiation.

The cosmic particle detector consists of two scintillation counters working in coincidence mode and gives a signal if a charged particle, mostly a muon, is crossing both scintillators. In addition there are three other sensors to measure the GPS coordinates and time, the temperature and air pressure near by the detector. A python program running on a Linux notebook steers data taking and storage on disk.

Work at sea

With the expedition ANT-XXIX/1 the experiment will be conducted for a third time. The scientific tasks are:

- Measurement of the number of cosmic muons in dependence on the latitude. The rate is expected to decrease with decreasing distance to the equator since the magnetic field of the earth guides the low energy particles to the poles. This geomagnetic effect will be measured. Existing data does not show the expected results. To understand this in detail, more data will be needed.
- The use of the weather measurement stations on board (especially OCEANET and the weather balloon) for the investigation of the influence of meteorological parameters on the intensity of the cosmic radiation.
- The preparation of a common station consisting of a muon detector (DESY) and a neutron monitor (Univ. Kiel, DESY and North-West Univ. South Africa) for long-term investigations of the sun activity and for an early warning system of sun eruptions. Such eruptions of high particle intensities influence the “cosmic weather” and especially electronics systems installed on earth or in satellites. There is a net of detectors installed in different countries and at research stations in Antarctica for an early warning system

of such dangerous events. With the *Polarstern* installation it would be possible to extend these measurements to the ocean area.

- The test of an improved detector generation and the study of their characteristics under operation conditions.

6. BATHYMETRY AND TECHNICAL TESTS AND CALIBRATIONS

R. Krocker, S. Krägefsky, N. Sandhop, E. Dunker (AWI, to Las Palmas), S. El Naggar (Laeisz, from Las Palmas), B. Dorschel (AWI), J. Gräser (AWI Potsdam, to Las Palmas)
G. König-Langlo (AWI, not on board)

Objectives and work at sea

The transfer cruise will also be used to install, test and calibrate new scientific sensors and equipment that shall be used during the following 1.5 years long research campaign in the Southern Ocean and Antarctica. New operators will be trained for the echosounders on board. In particular, the multi-beam Hydrosweep echosounder for bathymetry and the EK60 multi-frequency echosounder for fish and zooplankton measurements will be calibrated. In addition, new radio-sonde equipment for meteorological purposes and temperature sensors will be tested.

6.1 Test of underwater navigation system USBL-BOX

S. El Naggar (Laeisz), Ralf Krocker (AWI)

Objectives

The company IXSEA is providing an updated electronic device for underwater positioning and mooring release. Initial tests with this USBL-Box were executed during *Polarstern* cruise ANT-XXVIII/1 and an improvement of the signal detection, compared to the currently installed system POSIDONIA 6000, was observed. After these tests, the system's firmware was updated to fix some bugs and to improve the graphic display of targets. During this cruise the amended IXSEA USBL-Box will be tested again. The outcome of these tests will decide whether or not this new equipment should replace the currently installed POSIDONIA 6000 system.

Work at sea

During the expedition, the software settings of the amended USBL-BOX will be checked and the transponder will be prepared for mounting on the CTD. Furthermore, a range test will be performed to assess distance and direction in which the signals can be received and an AUV or ROV could be traced. The gathered navigation data and the data describing the quality of signal detection will be sent to IXSEA for subsequent evaluation.

The USBL-Box tests do not require additional station time and will be executed in combination with planned CTD casts and parallel to the mooring work on the Namibia Abyssal Plain.

6.2 Calibration of X-band wave radar "WAMOS"

S. El Naggar (Laeisz), Ralf Krocker (AWI)

Objectives

In June 2011 the WAMOS system from OceanWaveS GmbH was installed on board of *Polarstern* to measure the wave height and period and ocean surface current velocities. Following the adjustment of the X-band radar antenna related to ship's length axis in May 2012, new data will be gathered to evaluate the resulting improvements in the quality of the detected parameters. For quality assessment, the wave parameters will be checked against data recorded by a wave buoy (Data-Well). The shipboard system will be further developed and calibrated by integrating sensor data from the EM-Log, Doppler-Log and ADCP measuring the ships speed through water.

Work at sea

The data of the wave buoy and WAMOS as well as meteorological data and parameter of the ships movement will be sent to OceanWaveS GmbH for evaluation and calibration purposes. The new calibration values will be applied before repeating the measurements.

The tests do not require additional station time and will be executed in parallel to the planned work at the long term stations. The release and recovery of the wave buoy will take at maximum 15 minutes each. To locate the buoy and to speed up the recovery process, position data transmitted by the wave buoy will be used.

6.3 Hydrosweep: system test and training under expedition conditions

B. Dorschel, R. Krocker, N. Sandhop (AWI), S. El Naggar (Laeisz)

Objectives

In Oktober 2010, the multibeam echo sounder ATLAS HYDROSWEEP DS 2 was updated to version DS 3. In the new version, the so called, "crossfan calibration" for on-route calculation of the mean sound velocity (Cmean) is no longer available. For the DS-3 version, ATLAS has started to develop an alternative functionality. These efforts were, however, cancelled due to insolvable technical problems after initial data collection and developments during two previous *Polarstern* cruises. Alternatively, the hydro-acoustical determination of Cmean will now be calculated from crossing multibeam profiles. The general functionality of this procedure was confirmed during cruise ARK-XXVII/2. During cruise ANT-XXIX/1 the quality of calculated Cmean values will be assessed by comparison with results from CTD or SVP casts. A comparison with data from WOCE database will also be applied.

Since June 2012, the bathymetry group at AWI is headed by Mr. Boris Dorschel. To provide insights in all aspects of multibeam data acquisition and processing on board of *Polarstern*, he will receive training by an experienced hydrographer. Mrs. Nadja Sandhop will also be trained to operate the sonar system and to process sonar data independently during later cruises.

Work at sea

In order to calculate Cmean values with the new method, crossing multibeam profiles will be recorded in areas with low sea floor morphology. For quality control, the hydro-acoustically detected Cmean values will be checked against sound velocity profiles derived from CTD

measurements proximal and contemporary to the crossing multibeam profiles. CTD operations of other groups will also be supported.

The trainees will operate the sonar system and data acquisition from control PCs in the hydro acoustic office, the winch room and the bridge. The recorded CTD or SVP profiles will directly be used to adjust the multibeam system in order to minimize refractions. The post processing of the bathymetric data and the production of higher level bathymetric products will be performed on PCs in the hydro-acoustic office.

7. TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

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VUB	Vrije Universiteit Brussel Pleinlaan 2 1050 Elsen/Belgium

8. FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Adamopoulou	Argiro	UPMC Paris	Student biology (EMBC)
Albrecht	Cora Rabea	Uni Bremen	Student marine biology
Auel	Holger	BreMarE/Uni Bremen	Biological oceanographer
Bode	Maya	BreMarE/Uni Bremen	Marine biologist
Brückner	Marlen	Uni Leipzig	Meteorologist
Brunelli	Lisa	UPMC Paris	Student biology (EMBC)
Buonomo	Roberto	UPMC Paris	Student biology (EMBC)
Dehairs	Frank	VUB	Biogeochemist
Dorschel	Boris	AWI	Geologist
Dunker	Erich	AWI	Technician hydroacoustics
El Naggar	Saad	Reederei Laeisz	Physicist
Engelmann	Ronny	IfT Leipzig	Meteorologist
Garcia Vazquez	Eva	Uni Oviedo	Molecular biologist
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Hirche	Hans-Jürgen	AWI	Biologist
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Jungblut	Simon	Uni Oviedo	Student biology (EMBC)
Kanitz	Thomas	IfT Leipzig	Meteorologist
Kochzius	Marc	VUB	Biologist
Krägefsky	Sören	AWI	Biologist
Krocker	Ralf	AWI	Engineer bathymetry
Leistert	Michael	IfT Leipzig	Meteorologist
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Merkel	Maik	IfT Leipzig	Meteorologist
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Rembauville	Mathieu	UPMC Paris	Student biology
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Ribičić	Deni	Uni Klaipeda	Student biology (EMBC)
Ries	Felix	FIELAX	Technician
Rodrigues	Fernanda	UPMC Paris	Student biology (EMBC)
Sander	Hendrik	Optimare	Physical oceanographer

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Sandhop	Nadja	AWI/Uni Bremen	Student geography
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Schmidt	Katrin	AWI	Biologist
Schmidt-Petersen	Julia	Uni Oviedo	Student biology (EMBC)
Schwenke	Theresa	Uni Bremen	Student marine biology
Schwerdt	Carolin	DESY	Scientist
Shillington	Frank	UCT	Physical oceanographer
Smith	Joy	Uni Bremen/AWI	Biologist (MARES)
Sonnabend	Hartmut	DWD	Technician meteorology
Sotillo	Alejandro	Uni Gent	Biologist
Teuber	Lena	BreMarE/Uni Bremen	Biologist
van de Sande	Hilde	Uni Oviedo	Student biology (EMBC)
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Wolowicz	Maciej	Uni Gdansk	Biologist
Wu	Zhijun	IfT Leipzig	Meteorologist
Zaiko	Anastasija	Uni Klaipeda	Biologist
Zure	Marina	Uni Bremen/MPI	Biologist (MARES)

9. SCHIFFSBESATZUNG / SHIP'S CREW

Name	Rank
Schwarze, Stefan	Master
Grundmann, Uwe	1.Offc.
Farysch, Bernd	Ch. Eng.
Fallei, Holger	2. Offc.
Lesch, Florian	2.Offc.
NN	2.Offc.
Pohl, Claus	Doctor
Hecht, Andreas	R.Offc.
Sümnicht, Stefan	2.Eng.
Minzlaff, Hans-Ulrich	2.Eng.
Holst, Wolfgang	3. Eng.
Scholz, Manfred	Elec.Tech.
Fröb, Martin	Electron.
Muhle, Helmut	Electron.
Nasis, Ilias	Electron.
Himmel,Frank	Electron
Voy, Bernd	Boatsw.
Reise, Lutz	Carpenter
Scheel, Sebastian	A.B.
Brickmann, Peter	A.B.
Winkler, Michael	A.B.
Hagemann, Manfred	A.B.
Schmidt, Uwe	A.B.
Clasen, Nils	A.B.
Wende, Uwe	A.B.
Bäcker, Andreas	A.B.
Preußner, Jörg	Storek.
Teichert, Uwe	Mot-man
Schütt, Norbert	Mot-man
Elsner, Klaus	Mot-man
Plehn, Markus	Mot-man
Pinske, Lutz	Mot-man
Müller-Homburg, Ralf-Dieter	Cook
Silinski, Frank	Cooksmate
Martens, Michael	Cooksmate
Czyborra, Bärbel	1.Stwdess
Wöckener, Martina	Stwdss/KS
Gaude, Hans-Jürgen	2.Steward
Silinski, Carmen	2.Stwdess
Arendt, Rene	2.Steward
Möller, Wolfgang	2.Steward
Sun, Yong Shen	2.Steward
Yu, Kwok Yuen	Laundrym.

ANT-XXIX/2

30 November 2012 - 18 January 2013

Cape Town - Punta Arenas

Chief Scientist
Dr. Olaf Boebel

Coordinator
Dr. Rainer Knust

Contents

1. ÜBERBLICK UND FAHRTVERLAUF

Olaf Boebel
Alfred-Wegener-Institut

Am 30. November 2012 wird das Forschungsschiff *Polarstern* von Kapstadt zur Antarktisreise ANT-XXIX/2 auslaufen. Zunächst wird der Kurs nach Süd-Südwest führen um am Süd-West-Indischen Rücken Ozeanbodenseismometer auszulegen. Danach führt der Kurs an der Bouvetinsel vorbei zum Meridian von Greenwich den *Polarstern* bei 55°S erreichen wird. Von dort werden uns ozeanographische und biologische Arbeiten direkt nach Süden führen. Nach ersten geologischen Probennamen sollen die Arbeiten auf dem Meridian von Greenwich am 21. Dezember abgeschlossen sein, worauf *Polarstern* die Neumayer-Station zur Versorgung anlaufen wird. Anschließend wird das Weddellmeer durchquert, wo die nächste Phase der Arbeiten bis hin zur Nordspitze der Antarktischen Halbinsel geplant ist. Am 14. Januar 2013 werden die Arbeiten mit einer Verankerung bei Elefanteninsel abgeschlossen sein. Die Reise wird am 18. Januar 2012 in Punta Arenas enden. Die Fahrtroute ist in Abbildung 1.1 dargestellt.

Ziel der ozeanographischen Arbeiten ist, die Bedeutung des atlantischen Sektors des Südlichen Ozeans für die großräumigen klimarelevante Vorgänge besser zu verstehen. Hierzu werden während der gesamten Reise Messungen von Temperatur, Salzgehalt und der Meeresströmung vom fahrenden Schiff aus erfolgen. Entlang der Kurslinie werden vertikal profilierende NEMO Floats ausgelegt. Weiter südlich erfolgt die Aufnahme und Auslegung von Verankerungen, die Strömungs-, Temperatur- und Leitfähigkeitsmessgeräte, Schallquellen zur Ortung von Driftkörpern (Floats) und passiv akustische Rekorder tragen. An etwa 75 Stationen sind Messungen mit einem CTD-System (conductivity, temperature, depth) geplant, das mit Wasserschöpfern ausgestattet ist, um Proben zur Bestimmung von Salzgehalt und Sauerstoff zu erhalten.

Die Seismologie Arbeitsgruppe wird 11 Ozeanbodenseismometer (OBS) am Südwestindischen Rücken in einem Stationsabstand von 8 - 15 km im zentralen Rifttal eines amagmatischen Rückensegments installieren. Die OBS werden über ein Jahr lang die seismische Aktivität dieses Spreizungsrückens messen und dabei voraussichtlich mehrere tausend Erdbeben von geringer Magnitude aufnehmen.

Die Untersuchungen von Spurenmetallverhältnissen (Mg/Ca, U/Ca, B/Ca) in den Gehäusen von Foraminiferen ist eine gängige Methode, um Kalzifikationstemperatur, Salzgehaltsvariationen, Karbonationenkonzentration, pH und Alkalinität des Bodenwassers während des Gehäusebaues zu rekonstruieren. Auf dieser Expedition sollen mit einem Multicorer aus 1500 m Tiefe gewonnene Tiefseesedimente gewonnen und für Laborversuche in neuentwickelten Hochdruckaquarien und nach Bremerhaven überführt werden um Spezies-spezifische Spurenmetallkalibrationskurven für den Antarktischen Ozean zu entwickeln.

Die Abhängigkeit der Verbreitung und Häufigkeit von Vögeln und marinen Säugern von hydrologischen Faktoren, wie z.B. Fronten oder Meereis, soll durch die Erhebung von Sichtungsdaten entlang des *Polarstern* Transektes untersucht werden. Von besonderem Interesse sind hierbei die Auswirkungen klimatologisch bedingter Veränderungen des hydrologischen Umfeldes.

Im Rahmen des MAPS Projektes ist die kontinuierliche Erhebung von thermographischen Bilddaten geplant, um einen neu entwickelten Mustererkennungsalgorithmen zur automatisch Detektion von Walen validieren zu können. Um die Effizienz des Algorithmus bei verschiedenen Umweltbedingungen (Wassertemperatur, Eisbedeckung, Sichtweite) bestimmen zu können, sollen die Autodetektionsdaten mit sekundengenauen Walblas-Sichtungen eines weiteren Beobachterteams verglichen werden. finish

SUMMARY AND ITINERARY

On 30 November 2012 *Polarstern* will depart from Cape Town for the Antarctic expedition ANT-XXVIX/2. First, she will steam west-southwestward to deploy ocean bottom seismometers on the South-West-Indian Ridge. Passing Bouvet Island, she will continue towards the Greenwich meridian, which will be reached at 55°S. From there the expedition proceeds due South, conducting oceanographic and biological studies. It is planned that on 21 December activities along the Greenwich meridian should be finished after having collected first geological samples near the continental shelf break. *Polarstern* will then steam to Neumayer station to resupply the station for the next winter season. Thereafter, oceanographic and biological research activities will be continued across the Weddell Sea towards the tip of the Antarctic Peninsula. On 14 January, research activities will be completed with the deployment of a bioacoustic mooring near Elephant Island. The expedition will end in Punta Arenas on 18 January 2013. The cruise track is shown in Fig. 1.1.

The objective of HAFOS, the physical oceanography project, is to investigate the role of the Southern Ocean in the global climate system with focus on the Atlantic sector, including the Weddell Sea. To this end, temperature, salinity and ocean currents will be measured and profiling NEMO (Navigating European Marine Observer) floats will be deployed *en route*. An additional, yet essential part of the programme consists of the recovery and redeployment of deep-sea moorings. They contain current meters, temperature and conductivity sensors, sound sources and sound recorders. Measurements with a CTD probe (Conductivity, Temperature, Depth) will be performed at approximately 75 hydrographic stations and water samples will be taken to determine the concentration of salt and oxygen.

The seismology group will install 11 Ocean Bottom Seismometers (OBS) at an amagmatically spreading segment of the Southwest-Indian Ridge with a station spacing of about 8 - 15 km. Instruments will remain at the sea floor for approximately one year, recording several thousands of earthquakes of small magnitudes.

Analyses on trace metal (Mg/Ca, U/Ca, B/Ca) ratios recorded in tests of foraminifers to estimate calcification temperatures, salinity variations, carbonate ion saturation, pH and alkalinity are common methods. During this expedition we will retrieve multiple corers from 1,500 m water depth and transfer the retrieved sediments into newly developed high-pressure aquaria in Bremerhaven to establish species-specific trace metal calibration curves for the Antarctic Ocean.

The dependence of the distribution and density of birds and marine mammals on hydrologic factors such as fronts or sea-ice shall be studied by collecting transect counts of top predators. Particular emphasis is placed on effects of climatologic changes of the hydrological environment.

An automatic whale blow detection system was developed on the basis of thermographic images from a 360° scanning IR sensor. To validate its efficiency, visual observations and thermographic images shall be collected throughout the cruise. To test the efficiency of the detection algorithm for various species and under varying environmental conditions, auto-detections shall be compared with to-the-second sightings from an independent observer team.

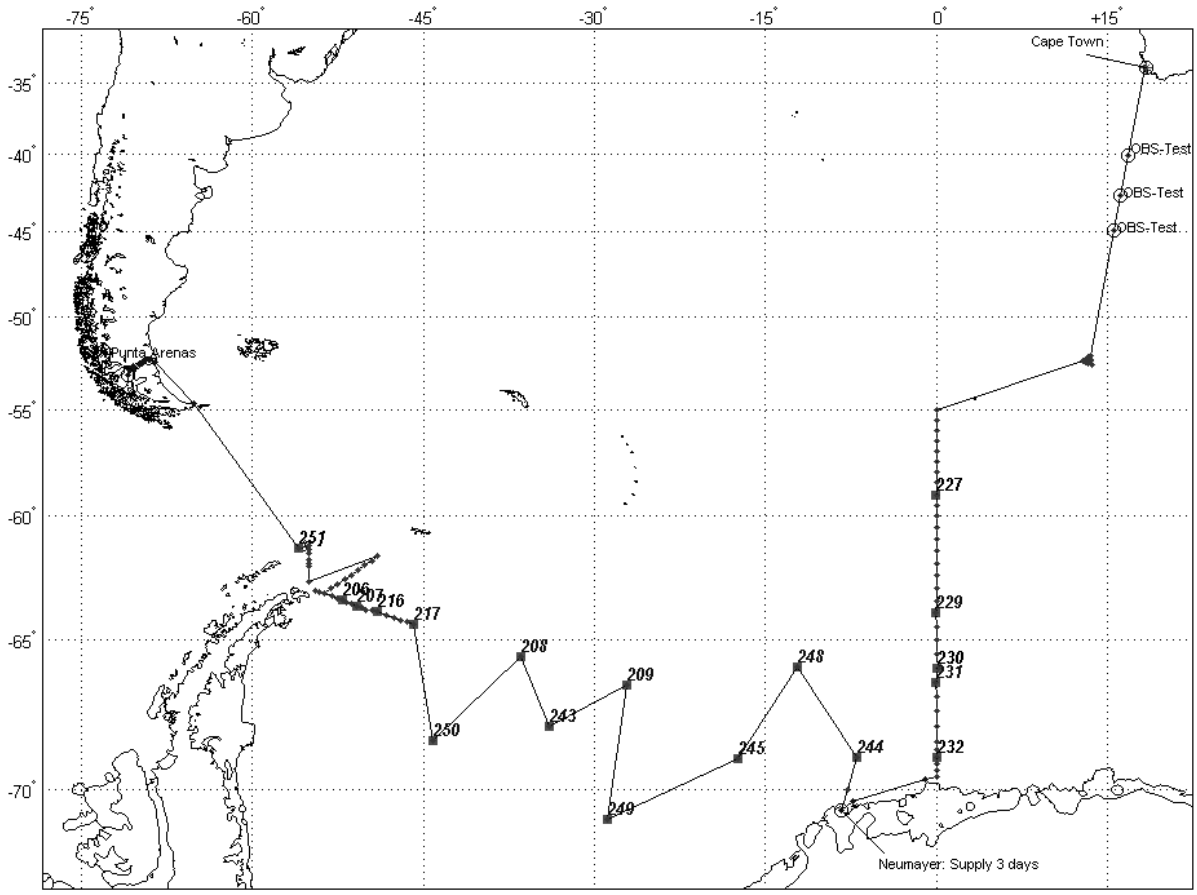

Abb.1.1: Karte des Untersuchungsgebietes und geplante Reiseroute der Expedition ANT-XXIX/2 (schwarze Linie). Punkte: CTD/Wasserproben Stationen. Quadrate mit kursiver Nummerierung: Ozeanographische Verankerungen. Punkte mit schwarzen Kreisen: OBS Teststationen. Dreieck: OBS Auslegepositionen. Sedimentproben werden nahe des antarktischen Schelfabbruchs genommen.

Fig. 1.1: Chart of the investigation area and the preliminary cruise track of ANT-XXIX/2 (black line). Dots: CTD/water sample station. Squares with italic numbers: oceanographic moorings. Dots with black circles: OBS test sites. Triangle: OBS deployment sites. Sediment samples will be taken in the vicinity of the Antarctic continental shelf break.

2. OCEANOGRAPHY

2.1 Implementation of the HAFOS Observation System in the Antarctic

O. Boebel, K. Lefering, N. Machner, S. Menze, M. Monsees, E. Nowatzki, L. Preis, S. Rettig, F. Rohardt, G. Rohardt, K. Thomisch, I. Van Opzeeland, W. Wei; NN, NN (AWI); R. Graupner (OPTIMARE); S. Brosch (SCHICKHARDT-GYMNASIUM); W. Zahn (FZ-JÜLICH)

Objectives

The densest bottom waters of the global oceans originate in the Southern Ocean. Production and export of these dense waters constitute an important component of the global climate system. The formation of dense water in polar areas is controlled by the balance between supply of fresh water through precipitation, and melt of continental and sea ice and the extraction of freshwater by sea ice formation and evaporation. As deep and bottom waters, they represent the deepest layer of the global overturning circulation. The influence of Southern Ocean waters can be traced into the Northern Hemisphere, far north of the Antarctic Circumpolar Current (ACC). The ACC is the world´s most powerful current system, transporting about 140 Sv (10^6 m^3 s^{-1}) of water at all depths. It connects the Pacific, Atlantic and Indian Ocean and forms a ring around the Antarctic continent. South of the ACC, in the subpolar region, warm and salty water masses are carried in the subpolar gyres to the continental margins of Antarctica. The most prominent are the Weddell and Ross Gyres. In the subpolar gyres, water mass modification occurs through ocean-ice-atmosphere interactions and mixing with adjacent water masses. The ACC is dynamically linked to meridional circulation cells, formed by southward ascending flow at intermediate depth and feeding into northward flow above and below. In the deep cell, water sinking near the continental water spreads to the adjacent ocean basins whereas in the shallow cell, the northward flow occurs in the surface layers. Dense waters are produced at several sites near the continental margins of Antarctica. Quantitatively the most important region for dense water formation may well be the Weddell Sea, however other areas provide significant contributions as well.

The basic mechanism of dense water generation involves upwelling of Circumpolar Deep Water, which is relatively warm and salty, into the surface layer where it comes into contact with the atmosphere and sea ice. The newly formed bottom water is significantly colder and slightly fresher than the initial Circumpolar Deep Water, which indicates heat loss and the addition of freshwater. Since freshwater input in the upper oceanic layers would impede sinking due to increasing stratification of the water column, it has to be compensated by salt gain through fresh water extraction. The upwelled water is freshened by precipitation and melting of glacial and sea ice. Freshwater of glacial origin is supplied from the ice shelves or melting icebergs. Ice shelves melt at their fronts and bases in response to the oceanic circulation in the cavity. Iceberg melting depends highly on the iceberg drift and can supply freshwater to areas distant from the shelves as the Antarctic frontal system. Due to the spatial separation of major sea-ice freezing and melting areas, cooling and salt release during sea-ice formation also help compensating the freshwater gain. Significant parts of salt accumulation occur on the Antarctic shelves in coastal polynyas. With extreme heat losses occurring only over ice free water areas, the polynyas are areas of intense sea ice formation. Offshore winds compress the newly formed sea ice and keep an open sea surface in the polynyas.

The cold and saline water accumulated on the shelves can descend the continental slope and mix with water masses near the shelf edge or it circulates under the vast ice shelves, where it is cooled further, below the surface freezing point, and freshened by melt water from the ice shelf. The resulting Ice Shelf Water spills over the continental slope and mixes with ambient waters to form deep and bottom water. For both mechanisms, relatively small scale processes at the shelf front, topographic features and the nonlinearity of the equation of state of sea water at low temperatures is of particular importance to induce and maintain the sinking motion. The various processes, topographic settings and the atmospheric forcing conditions lead to variable spatial characteristics of the resulting deep and bottom water masses which then spread along a variety of pathways to feed into the global oceanic circulation. Climate models suggest that dense water formation is sensitive to climate change. However, since the relatively small scale formation processes are poorly represented in the models, further improvement is needed.

The properties and volume of the newly formed bottom water underlies significant variability on a wide range of time scales, which are only scarcely explored due to the large efforts needed to obtain measurements in ice covered ocean areas. Seasonal variations of the upper ocean layers are only partially known and normally exceed other scales of variability in intensity. Impacts of longer term variations of the atmosphere-ice-ocean system, such as the Southern Hemispheric Annular Mode and the Antarctic Dipole, are only poorly observed and understood. Their influence on or interaction with oceanic conditions are merely guessed on the basis of models which are only superficially validated due to lack of appropriate measurements.

The extreme regional and temporal variability represents a large source of uncertainty when data sets of different origin are combined. Therefore circumpolar data sets of sufficient spatial and temporal coverage are needed. At present, such data sets can only be acquired by satellite remote sensing. However, to penetrate into the ocean interior and to validate the remotely sensed data, an ocean observing system is required, which combines remotely sensed data of sea ice and surface properties with *in-situ* measurements of atmospheric, sea ice and the ocean interior.

Significant progress towards this goal already occurred in the development of appropriate technology and logistics. Now the *Hybrid Antarctic Float Observing System* (HAFOS) observing system, which shall be installed during this expedition, aims to capitalize on these advances to investigate the ocean interior in the Atlantic Sector of the Southern Ocean, thereby extending the international *Argo* programme into the Weddell Sea and making an important step towards a *Southern Ocean Observing System* (SOOS).

Work at sea

The oceanographic studies during *Polarstern* cruise ANT-XXIX/2 will concentrate on two major areas, the Greenwich Meridian and the Weddell Sea, continuing past *in-situ* observations in the Atlantic sector of the Southern Ocean using moored instruments to provide time series of water mass properties throughout the deep and the surface layers. For this purpose, moorings, which feature current meters, temperature and salinity sensors, sound sources and passive acoustic recorders, will be recovered and redeployed (Tables 2.1 – 2.4).

To enhance the vertical resolution and to calibrate moored sensors, a total of about 75 CTD stations are planned along the cruise track. The CTD/water sampler consists of a SBE911plus CTD system in combination with a carousel water sampler SBE32 with 24 12-l bottles. To determine the distance to the bottom an altimeter from Benthos is mounted. A

transmissiometer from Wetlabs, a SBE43 oxygen sensor from Seabird Electronics and a fluorometer will be incorporated in the sensor package.

To extend observations horizontally, Argo compatible NEMO floats will be deployed along the cruise track. The drift of these NEMO floats will lead to a horizontal dispersion of sampling sites across the Weddell Gyre. Moorings will contain sound sources, providing RAFOS signals for retrospective under-ice positioning of NEMO floats. During ANT-XXIX/2, about 40 NEMO floats will be deployed across the ACC and the Weddell Sea. In addition, 1 NEMO will be deployed north of 50°S on behalf of Bundesamt für Seeschifffahrt und Hydrographie (BSH).

Table 2.1: Moorings to be recovered on the Greenwich meridian

Mooring	Latitude Longitude	Water Depth (m)	Date Time (at Depth)	Instrument Type	Serial Number	Instrument Depth (m)
AWI232-10	69° 00.11' S	3370	19.12.2010	ULS	69	150
	00° 00.11' W		10:20	AVTP	8400	250
				AVT	9219	750
				PAM	1003	1250
				RCM 11	212	1800
				POD	403	2000
				SBE37	441	3300
				RCM 11	216	3300
AWI231-9	66° 30.71' S	4524	17.12.2010	ULS	68	150
	00° 01.54' W		12:00	AVTP	8367	200
				SBE37	249	200
				SBE37	232	250
				SBE37	233	300
				SBE37	235	350
				SBE37	236	400
				SBE37	1230	450
				SBE37	238	500
				SBE37	239	550
				SBE37	2388	600
				SBE37	437	650
				SBE37	1232	700
				RCM 11	145	700
				SOSO	29	850
				PAM	1002	1000
				AVT	9212	1800
				SBE37	440	4500
				RCM 11	146	4500
AWI230-7	66° 01.90' S	3540	16.12.2010	AVTP	10539	200
	00° 03.25' E		20:00	SBE37	8125	200
				SBE37	227	300
				SBE37	246	400
				SBE37	228	500
				SBE37	229	600
				SBE37	247	700
				RCM 11	102	700
				PAM	1001	1000
				AVTP	9211	1600
				SBE37	231	3500
				RCM 11	133	3500
AWI229-9	63° 59.56' S	5170	15.12.2010	ULS	67	150

Mooring	Latitude Longitude	Water Depth (m)	Date Time (at Depth)	Instrument Type	Serial Number	Instrument Depth (m)
	00° 002.65' W		16:28	AVTP	10926	200
				SBE37	2719	200
				SBE37	241	250
				SBE37	215	300
				SBE16	216	350
				SBE37	218	400
				SBE37	2720	450
				SBE37	224	500
				SBE37	225	550
				SBE37	226	600
				SBE37	2382	650
				SBE37	2722	700
				AVTP	8037	704
				SOSO	17	850
				PAM	1000	1000
				RCM 11	501	2000
				SBE37	2383	5150
				RCM 11	134	5150
AWI227-11	59° 03.02'S	4600	11.12.2010	PAM	0002	1000
	00° 06.63' W		18:28	SBE16	630	4540

Table 2.2: Moorings to be recovered along transect from Kapp Norvegia towards Joinville Island

Mooring	Latitude Longitude	Water Depth (m)	Date Time (at Depth)	Instrument Type	Serial Number	Instrument Depth (m)
AWI244-2	69° 00.30' S	2900	23.12.2010	SOSO	02	700
	06° 58.89' W		10:27	SOSO	30	800
				PAM	1005	900
AWI245-2	69° 03.52' S	4740	27.12.2010	SOSO	24	800
	17° 23.05' W		11:00	PAM	1004	1000
AWI209-6	66° 36.70' S	4830	29.12.2010	PAM	086	200
	27° 07.31' W		15:15	SBE37	1233	300
				SOSO	23	800
				SBE37	1603	4775
				SBE37	442	4825
AWI243-1	68° 00.67' S	4443	31.01.2007	SOSO	31	800
	34° 00.15' W		06:15	SBE37	217	4436
AWI208-6	65° 37.06' S	4740	01.01.2011	ULS	66	150
	36° 25.28' W		17:49	SBE37	1234	300
				SOSO	29/34	800
				SBE37	1606	4680
				SBE37	444	4730
AWI217-4	64° 23.88' S	4416	04.01.2011	SOSO	28/27	810
	45° 51.95' W		17:57	SBE37	1564	4320
				SBE37	2087	4370
				RCM 11	217	4372
AWI216-4	63° 53.66' S	3500	05.01.2011	SBE37	2395	3300
	49° 05.20' W		15:57	SBE37	448	3400
				SBE37	2611	3450
				RCM 11	219	3451

Mooring	Latitude Longitude	Water Depth (m)	Date Time (at Depth)	Instrument Type	Serial Number	Instrument Depth (m)
AWI207-8	63° 43.20’ S 50° 49.54’ W	2500	06.01.2011 12:26	ULS RCM 11 SBE37 AVT SOSO POD SBE37 SBE37 RCM 11 SBE37 RCM 11	63 294 1235 8405 32 845 2235 1605 297 1607 311	150 250 251 750 850 2100 2100 2200 2300 2490 2490
AWI206-7	63° 28.93’ S 52° 05.87’ W	950	06.01.2011 20:52	ULS AVTP SBE37 RCM 11 SBE16 POD SBE37 PAM RCM 11	65 8417 2723 312 2418 844 2097 1006 313	150 250 500 501 700 750 900 910 912

Table 2.3: Moorings to be deployed on the Greenwich meridian

Mooring	Latitude Longitude	Water Depth (m)	Instrument Type	Instrument Depth (m)
AWI232-11	69° 00.11’ S 00° 00.11’ W	3370	AVT AVT PAM RCM 11 SBE37 RCM 11	250 750 1250 1800 3300 3300
AWI231-10	66° 30.71’ S 00° 01.54’ W	4524	AVT SBE37 SBE37 SBE37 SBE37 SBE37 SBE37 SBE37 SBE37 SBE37 SBE37 SBE37 RCM 11 SOSO AVT SBE37 RCM 11	200 200 250 300 350 400 450 500 550 600 650 700 700 850 1800 4500 4500
AWI230-8	66° 01.90’ S 00° 03.25’ E	3540	AVT SBE37 SBE37	200 200 300

Mooring	Latitude Longitude	Water Depth (m)	Instrument Type	Instrument Depth (m)
			SBE37	400
			SBE37	500
			SBE37	600
			SBE37	700
			RCM 11	700
			PAM	1000
			AVT	1600
			SBE37	3500
			RCM 11	3500
AWI229-10	63° 59.56' S	5170	AVTP	200
	00° 002.65' W		SBE37	200
			SBE37	250
			SBE37	300
			SBE16	350
			SBE37	400
			SBE37	450
			SBE37	500
			SBE37	550
			SBE37	600
			SBE37	650
			SBE37	700
			AVT	704
			SOSO	850
			PAM	1000
			RCM 11	2000
			SBE37	5150
			RCM 11	5150
AWI227-12	59° 03.02'S	4600	PAM	1000
	00° 06.63' W		SBE16	4540

Table 2.4: Moorings to be deployed along transect from Kapp Norvegia towards Joinville Island

Mooring	Latitude Longitude	Water Depth (m)	Instrument Type	Instrument Depth (m)
AWI244-3	69° 00.30' S	2900	SOSO	800
	06° 58.89' W		PAM	1000
			SB37	2850
AWI248-1	65° 58.16' S	5020	SOSO	800
	12° 15.01' W		PAM	1000
			SB37	4980
AWI245-3	69° 03.52' S	4740	SOSO	800
	17° 23.05' W		PAM	1000
			SBE37	4690
AWI249-1	70° 53.67' S	4360	SOSO	800
	28° 51.99' W		PAM	1000
			SBE37	4320
AWI209-7	66° 36.70' S	4830	PAM	200
	27° 07.31' W		SBE37	210
			SOSO	800

Mooring	Latitude Longitude	Water Depth (m)	Instrument Type	Instrument Depth (m)
			SBE37	4775
			SBE37	4825
AWI208-7	65° 37.06’ S	4740	SBE37	300
	36° 25.28’ W		SOSO	800
			PAM	1000
			SBE37	4680
			SBE37	4730
AWI250-1	68° 29.51’ S	4080	SOSO	800
	44° 07.02’ W		PAM	1000
			SBE37	4030
AWI217-5	64° 23.88’ S	4416	SOSO	810
	45° 51.95’ W		SBE37	4320
			SBE37	4370
			RCM 11	4372
AWI216-5	63° 53.66’ S	3500	SBE37	3300
	49° 05.20’ W		SBE37	3400
			SBE37	3450
			RCM 11	3451
AWI207-9	63° 43.20’ S	2500	PAM	200
	50° 49.54’ W		RCM 11	250
			SBE37	251
			AVT	750
			SOSO	850
			SBE37	2100
			SBE37	2200
			RCM 11	2300
			SBE37	2490
			PAM	2490
			RCM 11	2490
AWI206-7	63° 28.93’ S	950	AVTP	250
	52° 05.87’ W		SBE37	500
			RCM 11	501
			SBE16	700
			SBE37	900
			PAM	910
			RCM 11	912
AWI251-1	61° 22.10’ S	300	ADCP	250
	56° 00.10’ W		PAM	500
			SBE37	900

Abbreviations:

AURAL	AURAL-Underwater Acoustic Recorder
AVTCP	Aanderaa Current Meter with temperature-, conductivity- and pressure sensor
AVTP	Aanderaa Current Meter with temperature- and pressure sensor
AVT	Aanderaa Current Meter with temperature sensor
PAM	Passive Acoustic Monitor (Type: AURAL or SONOVAULT)
POD	Porpoise detector
RCM 11	Aanderaa doppler current meter
SBE16	SeaBird Electronics self recording CTD to measure temperature, conductivity and pressure

SBE37	SeaBird Electronics, Type: MicroCat, to measure temperature and conductivity
SOSO	RAFOS sound source

Expected results

We expect to secure data from a large proportion of the instruments currently moored, together with ship-based CTD data.

Data policy

Metadata of recorded data will be made available through the cruise report. Mooring and CTD data will be made available after validation through the PANGAEA database. Float data will be made available through the Argo System. Results will be published in international journals.

3. GEOSCIENCES

3.1. Seismology: seismicity of the ultraslow-spreading Southwest-Indian Ridge

V. Schlindwein, E. Korger, J. Gossler; not on board N. Lensch (AWI)

Objectives

Ocean basins are formed by seafloor spreading at active mid-ocean ridges. Mantle material is upwelling under the ridges and melts to produce magma, which erupts onto the sea floor and crystallises at depth to produce new oceanic crust. Crustal generation and plate separation rate keep pace over a wide range of spreading rates and produce oceanic crust with a uniform thickness of about 7 km. Yet, models predict that at spreading rates below about 20 mm/y, the mantle loses heat by conduction and only small amounts of melt are produced at large depths. Consequently, magmatism and crustal thickness should decrease with decreasing spreading rate. Volcanic eruptions should be unlikely at ultraslow-spreading ridges (< 20 mm/y). Until recently, very little data from ultraslow-spreading ridges were available to verify this theory because these ridges are located in remote ocean basins like the ice covered Arctic Ocean and the stormy Southern Ocean.

Contradicting the common theory, ultraslow-spreading ridges are divided into segments with pronounced volcanism and segments lacking any signs of mantle melting, their distribution being independent of the spreading rate. New models are therefore necessary to describe the processes of crustal generation at ultraslow-spreading ridges.

Microearthquakes image the active tectonic and magmatic processes at mid-ocean ridges and therefore help to understand crustal generation. At ultraslow-spreading ridges the microseismicity is hardly explored. The junior research group “MOVE” at AWI studies the seismicity of ultraslow-spreading ridges in various projects. Up to now, we have mainly studied the Arctic ridge system, which is tectonically less complicated than the Southwest-Indian ridge (SWIR). In the Arctic, we used land seismometers installed on drifting ice floes to record earthquakes as small as magnitude 1 or below. The drawback of this method is that we could only acquire data for time periods of 2 - 3 weeks, which is very little to record statistically representative numbers of earthquakes.

We therefore focus our current research activities at the SWIR, which is located halfway between Africa and Antarctica. The open waters allow using Ocean Bottom Seismometers (OBS), which are deployed on the seafloor and can remain there for a period of about one year and thus record sufficiently high numbers of small earthquakes. Up to now, no *in-situ* records of the seismicity of the SWIR exist, because the recovery of the OBS in stormy waters is risky. In addition, the SWIR is not an ideal candidate for studying ridge processes as it is tectonically complicated, being oriented obliquely to the direction of plate motion. Especially at the eastern part of the SWIR, magmatic and amagmatic crustal production are unstable in time and space such that a complicated structure results.

In our current project, we want to compare the seismicity and structure of a site of magmatic crustal production and a site of amagmatic crustal production. For the magmatic site, we chose a recently active submarine volcano at the eastern SWIR. It will be instrumented by other members of the junior research group during a cruise with *Marion Dufresne* in September and October 2012. This expedition is part of a large international collaboration to image the hotspot underlying the island of La Reunion. During the current *Polarstern* expedition, we will deploy 11 seismometers at an amagmatic site at the western SWIR. Here, at about 13°E and 52°S in about 4,500 m water depth, we want to explore the processes that bring mantle rocks to the seafloor forming an entirely amagmatic crust. In addition, hydrothermal discharge into the water column has been discovered in this area. Microearthquakes are able to track circulating fluids and can therefore help to understand amagmatic hydrothermal systems. We will visit this site again in one year time during ANT-XXIX/8 and recover our instruments. ANT-XXIX/8 will be mainly dedicated to the exploration of the hydrothermal system and will remain in the survey area for many days, such that we will have good chances to recover the OBS in favourable weather conditions. The seismometers will then have stored several thousands of small earthquakes in their internal data logger, the location of which can tell us for example about the maximal depth of faulting and thus the thermal structure of the lithosphere.

Work at sea

During the layover of *Polarstern* in Cape Town, we plan to assemble our OBSs to an almost complete extent: It will be necessary to place the OBSs on steel anchor weights by crane and all instruments, including the data logger and the seismometer itself along with their power supply, will then be mounted on the titanium frame of the OBS, partly in solid titanium pressure tubes. When at sea, we will test the releasing units by strapping them onto a frame and winching them down to several thousand meters of water depth. We will test whether they function correctly, before mounting them to the OBS frames. Once in the survey area immediately before deployment, we will program the data logger and synchronize the internal OBS clock with GPS time. In poor weather conditions we will simply drop the instruments from the crane and let them fall freely to their planned position. However, as the terrain near the ridge is very rugged, we would prefer to identify spots with indications for a sedimentary cover and we will try to hit these spots by lowering the OBSs on a cable equipped with a Posidonia positioning transponder. This operation will take about 3 - 4 hours per OBS and can only be done in suitable weather conditions. This would give us both an indication of the extent of lateral drift of the seismometer during its way to the seafloor at more than 4 km depth, and some control of the OBS position on the seafloor. The instruments will be positioned in a network around the central rift valley with a station spacing of 8 - 15 km. Thus transfer times between the drop sites will be short. We expect the OBS deployment to take about two days.

Expected results

We expect to record several thousands of earthquakes of small magnitudes. However, the data will only be accessible after the recovery cruise in 2013. Therefore, the present cruise will not yield any data for immediate use.

Data management

Our seismic data will be archived in a common data repository for all data acquired with the OBSs of the DEPAS instrument pool. This archive is currently being developed and implemented at AWI and will be available by 2013. After 3 years of restricted access, the data will be made publicly available through the GEOFON seismic data request system.

3.2. Tracemetals

E. Wurz; not on board: J. Wollenburg (AWI)

Objectives

The Antarctic Ocean is one of our most important climate amplifiers: First, the production of Antarctic deep water drives the Global Thermohaline Conveyer Belt, thus, climate. Second, the Antarctic deep water during glacial time was and disputably still is the largest marine sink of atmospheric CO_2. Employment of effective sensitive and in geological sense preservable proxies to obtain precise information on changes in the polar deep ocean's physical to geochemical properties are essential to assess past, modern, and future physical to geochemical changes in bipolar deep-waters. In this respect, analyses of trace metal (Mg/Ca, U/Ca, B/Ca) ratios recorded in tests of foraminifers to estimate calcification temperatures, salinity variations, carbonate ion saturation, pH and alkalinity became common methods. However, for the Southern Ocean, deep-sea benthic foraminifera calibration curves constrained by culture experiments are lacking. During this expedition we will retrieve multiple corers from 1,500m water depth and transfer the retrieved sediments into 15 different aquaria including newly developed high-pressure aquaria. These aquaria will be used in different experimental set-ups to cultivate our most trusted paleodeep-water recorders at different temperatures and in waters with different carbonate chemistries to establish species-specific trace metal calibration curves for the Antarctic Ocean.

Work at sea and expected results

Since our work is focused on epizooic *Cibicides*-type foraminifers, filter-feeding unilocular animals with maxima abundances in areas of high current activities, we will deploy 2 - 3 multiple cores at exposed sites with a water depth around 1,500 m. The retrieved cores will be transferred into a cold laboratory running at site-alike bottom water temperature during the cruise. During the last day on board, the sediments and overlaying water will be transferred into transfer-cores and storage systems. These storage systems will be transferred into special cold boxes ensuring site-alike temperature during the flight to Bremerhaven. In Bremerhaven the sediments will immediately be transferred into the respective aquaria and connected to respective supportive sea-water systems.

Data management

This work is part of a bipolar DFG-project on the incooperation of trace metals in benthic deep-sea foraminifera. The results will be published in international journals within approx. 2 years after the expedition.

4. BIOLOGY

4.1. Higher trophic levels: at-sea distribtuion of seabirds and marine mammals

D. Verbelen, R. Lebrun, D. D'Hert; not on board: C.R. Joiris (PolE)

Objectives

In the framework of our long-term studies of the at-sea distribution of seabirds and marine mammals in polar marine ecosystems, the main aims are:

- to study in more detail the hydrological factors influencing their density: water masses and pack ice, fronts and ice edge (*i.e.* ecological factors, mainly prey abundance);

- to detect temporal and spatial changes in density, with special attention to possible effects of global changes, with consequences on ice coverage: mainly decreasing in the Arctic, while in the Antarctic some regions show very important decrease (*e.g.* around the Peninsula) but others might show an increase - including the eastern Weddell Sea, resulting in an apparently stable balance for the whole Antarctic (discussion in Joiris, 2011a).

In the case of ANT-XXIX/2, special zones to be studied are the Cape-Town – Neumayer transect on the one hand, already studied 4 times during recent years (Joiris and De Broyer, submitted and in prep); on the other hand, data obtained in the Weddell Sea during the EPOS 1 expedition will serve as baseline information for such a comparison (Joiris 1991, 2000).

Work at sea

The basic methodology consists in transect counts from the bridge, without width limitation, on a continuous basis, light and visibility conditions allowing (for description and discussion of the method, see Joiris and Falck 2010, Joiris 2011a). As a complement, helicopter flights will help detecting possible high bird and/ or cetacean concentrations, as well as allowing comparison with the bridge observations.

Expected results

Polar marine ecosystems being characterized by low biodiversity – few species, of which a few represent the majority of numbers – the main hope is to detect local large to very large concentrations ("it all happens there" e.g. Joiris 2010, Joiris and Falck 2010).

Data management

Results will be prepared as data sets, and made available to all participants a few months after end of the expedition. Publication(s) in international journals will follow within approx. 2 years after the end. When possible, priority will be given to common papers with other teams: oceanography, zooplankton and nekton, pelagic fish.

References

Joiris CR and De Broyer A. Submitted. Seabirds encountered along return transects between South Africa and Antarctica in summer.

Joiris CR and De Broyer A. In prep. Marine mammals encountered along return transects between South Africa and Antarctica in summer.

Joiris CR (2011a) Possible impact of decreasing Arctic pack ice on the higher trophic levels - seabirds and marine mammals. Adv. Environm. Res. 23: 227-241.

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DOI: 10.1007/s00300-011-1022-1. Online: 27 May, 2011.

Joiris CR and Falck E (2010) Summer at-sea distribution of little auks Alle alle and harp seals Pagophilus (Phoca) groenlandica in the Greenland Sea: impact of small-scale hydrological events. Polar Biol. (2011) 34: 541-548. DOI: 10.1007/s00300-010-0910-0. Online: 03 November 2010.

4.2 MAPS: Marine Mammal Perimeter Surveillance

O. Boebel, A. Bombosch, A. Cammereiri, D. Zitterbart, (AWI); S. Richter (Uni Erlangen)
Not on board: E. Burkhardt, L. Kindermann (AWI)

Objectives

Both, non-governmental organizations and governmental agencies increasingly criticize the use of air-guns for marine geophysical research due to the enhanced noise levels these instruments introduce to the aquatic environment. To remedy possible detrimental effects to the marine fauna, mitigation measures are commonly requested, which in most cases imply visual observation of the ship's perimeter and shut down of seismic operations when whales are sighted within a predefined exclusion zone around the airguns. To facilitate such observations, the MAPS project aims at developing an automatic whale blow detection system on the basis of a 360° thermal imaging sensor, FIRST Navy.

Data collected with this system during several *Polarstern* cruises resulted in the development of a computer algorithm which automatically detects whale blows, resulting in issuing a real-time alert to the marine mammal observers and ship's crew. During this expedition, our goal is to test the operational procedures and to determine the efficiency of the algorithm. This requires considering two questions:

1. What is the number of missed events (i.e. whales present which are not detected by the automated algorithm).
2. What is the number of false positives (i.e. events such as breaking waves that the automated algorithm mistakenly identifies as whale blows).

Work at sea

During the cruise, two data sets will to be collected independently: a) video snippets of automatic IR based detections and b) protocols visual sightings by independent observers. Due to the IR system's immense requirements for data storage (3.5 TBytes per day), it is not possible to continuously save IR data for the entire cruise. Rather, IR video snippets will be saved on the basis of automated IR detections and on the basis of the above mentioned visual sightings. The resulting data set shall be used for retrospective validation of the auto-detector for its efficiency. To this end, the exact time (to the second), direction and distance of any visual sighting need to be recorded, preferably together with information on which species sighted was.

Expected results

This effort is expected to result in the collection of a comprehensive data set for further system validation, behavioural analysis and our marine mammal sighting database. Sighting data will be merged with environmental proxies such as sea-ice conditions, water depth and sea surface temperature to be used in environmental suitability models. Behavioural analysis will provide high resolution tracks of marine mammals in the vicinity of the ship, including the distribution of concurrent ice-floes. System validation will lead to improved algorithms, with the aim to minimize the amount of false alerts.

Data management

Metadata of recoded data will be made available through the cruise report. Data will be made available upon request. Results shall be published within 2 years in international journals.

5. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adresse / Address
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6. FAHRTTEILNEHMER / PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
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Bombosch	Annette	AWI	Biologist
Brosch	Sabine	Schickhardt-Gymnasium	Teacher
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D'Hert	Diederik	PolE	Biologist
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NN			Observer
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Verbelen	Dominique	PolE	Biologist
Wei	Wei	AWI	Oceanographer
Wurz	Erik	AWI	Student, Geosciences
Zahn	Wolfgang	FZ-Jülich	Oceanographer
Zitterbart	Daniel	AWI	Physicist

7. SCHIFFSBESATZUNG / SHIP'S CREW

Name	Rank
Pahl, Uwe	Master
Grundmann, Uwe	1.Offc.
Farysch, Bernd	Ch. Eng.
Fallei, Holger	2. Offc.
Lesch, Florian	2.Offc.
Rackete, Carola	3.Offc.
Pohl, Claus	Doctor
Hecht, Andreas	R.Offc.
Sümnicht, Stefan	2.Eng.
Minzlaff, Hans-Ulrich	2.Eng.
Holst, Wolfgang	3. Eng.
Scholz, Manfred	Elec.Tech.
Dimmler, Werner	Electron.
Hüttebräucker, Olaf	Electron.
Nasis, Ilias	Electron.
Himmel,Frank	Electron
Loidl, Reiner	Boatsw.
Reise, Lutz	Carpenter
Scheel, Sebastian	A.B.
Brickmann, Peter	A.B.
Winkler, Michael	A.B.
Hagemann, Manfred	A.B.
Schmidt, Uwe	A.B.
Guse, Hartmut	A.B.
Wende, Uwe	A.B.
Bäcker, Andreas	A.B.
Preußner, Jörg	Storek.
Teichert, Uwe	Mot-man
Schütt, Norbert	Mot-man
Elsner, Klaus	Mot-man
Voy, Bernd	Mot-man
Pinske, Lutz	Mot-man
Müller-Homburg, Ralf-Dieter	Cook
Silinski, Frank	Cooksmate
Martens, Michael	Cooksmate
Czyborra, Bärbel	1.Stwdess
Wöckener, Martina	Stwdss/KS
Gaude, Hans-Jürgen	2.Steward
Silinski, Carmen	2.Stwdess
Arendt, Rene	2.Steward
Möller, Wolfgang	2.Steward
Sun, Yong Shen	2.Steward
Yu, Kwok Yuen	Laundrym.

ANT-XXIX/3

20 January - 19 March 2013

Punta Arenas - Punta Arenas

Chief scientist
Prof. Dr. Julian Gutt

Coordinator
Dr. Rainer Knust

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1. ÜBERBLICK UND FAHRTVERLAUF

J. Gutt, M. Schröder (AWI), V. Siegel (vTI-SF)

Der Fahrtabschnitt ANT-XXIX/3 wird am 20. Januar 2013 in Punta Arenas (Chile) beginnen und dort am 19. März 2013 enden. Die wissenschaftlichen Arbeiten gliedern sich in zwei Projekte: “Larsen Shelf Study of the Ocean” (LASSO), ein biologisch-ozeanografisches Vorhaben im Larsen A/B Gebiet sowie vor dem Larsen C Schelfeis östlich der Antarktischen Halbinsel. Diese Untersuchungen dienen der Antarktis-spezifischen Klimaforschung und sind in das neue Biologie-Projekt “Antarctic Thresholds – Ecosystem Resilience and Adaptation [Antarktische Schwellenwerte – Erholungsfähigkeit und Anpassung von Ökosystemen]" (AnT-ERA) vom „Scientific Committee on Antarctic Research" (SCAR) eingebunden. Das zweite Projekt ist eine Krill-Studie im nordwestlichen Weddellmeer, die einen Beitrag zum “Übereinkommen zum Schutz der lebenden Meeresschätze in der Antarktis” (CCAMLR) leistet. Die Abfolge der Arbeiten in den Untersuchungsgebieten (Abb. 1.1) wird erst nach dem Auslaufen in Punta Arenas entschieden, um die aktuelle Meereissituation zu berücksichtigen.

Experten stellten im Antarktis-Klimareport (ACCE) fest, dass das plötzliche Wegbrechen der Larsen A und B Schelfeise, insbesondere in den Jahren 1995 und 2002, in erster Linie auf großräumige regionale atmosphärische Erwärmung zurückzuführen ist. Dieser Prozess wird sich mit noch unbekannter Geschwindigkeit nach Süden ausdehnen und hat erhebliche Folgen für die physikalische und biologische Umwelt.

Vor diesem Hintergrund soll **der ökologische Schwerpunkt des LASSO-Projektes** den Einfluss des Klima-bedingten Scheifeis-Kollapses auf marinen Lebensgemeinschaften des Kontinentalsockels abschätzen. Eine erste ökologische Studie fand bereits 2007 während ANT-XXIII/8, eine weitere Probennahme während ANT-XXVIII/3 statt. Es gibt zusätzliche Informationen, insbesondere zur Palaeo-Ökologie von dem US Antarktisprogramm LARISSA. Es wurde offensichtlich, dass sich das marine Ökosystem als Ganzes in einem Übergang zwischen dem ehemalig nahrungsarmen (oligotrophen) und einem normalen antarktischen Zustand mit kurzer sommerlicher Algenblüte (Primärproduktion) befindet.

Die Sedimente in dem Gebiet decken einen extremen Gradienten von anliegendem Fels und groben Gesteinsbrocken am küstennahen Rand bis zu weichem Material in der zentralen Depression (Larsen B) ab. Seit dem Schelfeis-Kollaps gibt es durch eine in die Larsen B Bucht gerichtete bodennahe Strömung an deren süd-östlichem “Eingang” einen potentiell erheblichen Nahrungseintrag. Die lokale Primärproduktion scheint von einem ozeanographischen Wirbel in Abhängigkeit von der Bodentopografie und der jeweiligen Eisbedeckung geprägt zu sein. Die verschiedenen Ökosystemkomponenten reagieren auf die dramatischen Veränderungen durch den Schelfeisabbruch offensichtlich mit unterschiedlicher Geschwindigkeit. In Folge der Algenblüte konnten lockere Krill-Schwärme im freien Wasser beobachtet werden. Säugetiere waren insbesondere durch Antarktische Zwergwale und Krabbenfresserrobben vertreten; Pinguine waren sehr selten. Die benthische Meiofauna scheint schneller zu reagieren als das Makrobenthos. Der Anteil wissenschaftlich tentativ neuer Arten unter den benthischen Ruderfußkrebsen ist extrem hoch. Die Megafauna war durch Tiefsee- und Pionierarten gekennzeichnet. Durch die langfristige Vereisungsgeschichte und/oder die unterschiedliche Zeit, die seit dem Schelfeiskollaps verstrichen ist, zeigen sich erhebliche Unterschiede zwischen dem Larsen A und B Gebiet.

Faunistische Ähnlichkeiten gab es nur nördlich und südlich des verbliebenen Schelfeis-Streifens zwischen dem Larsen A und B Gebiet.

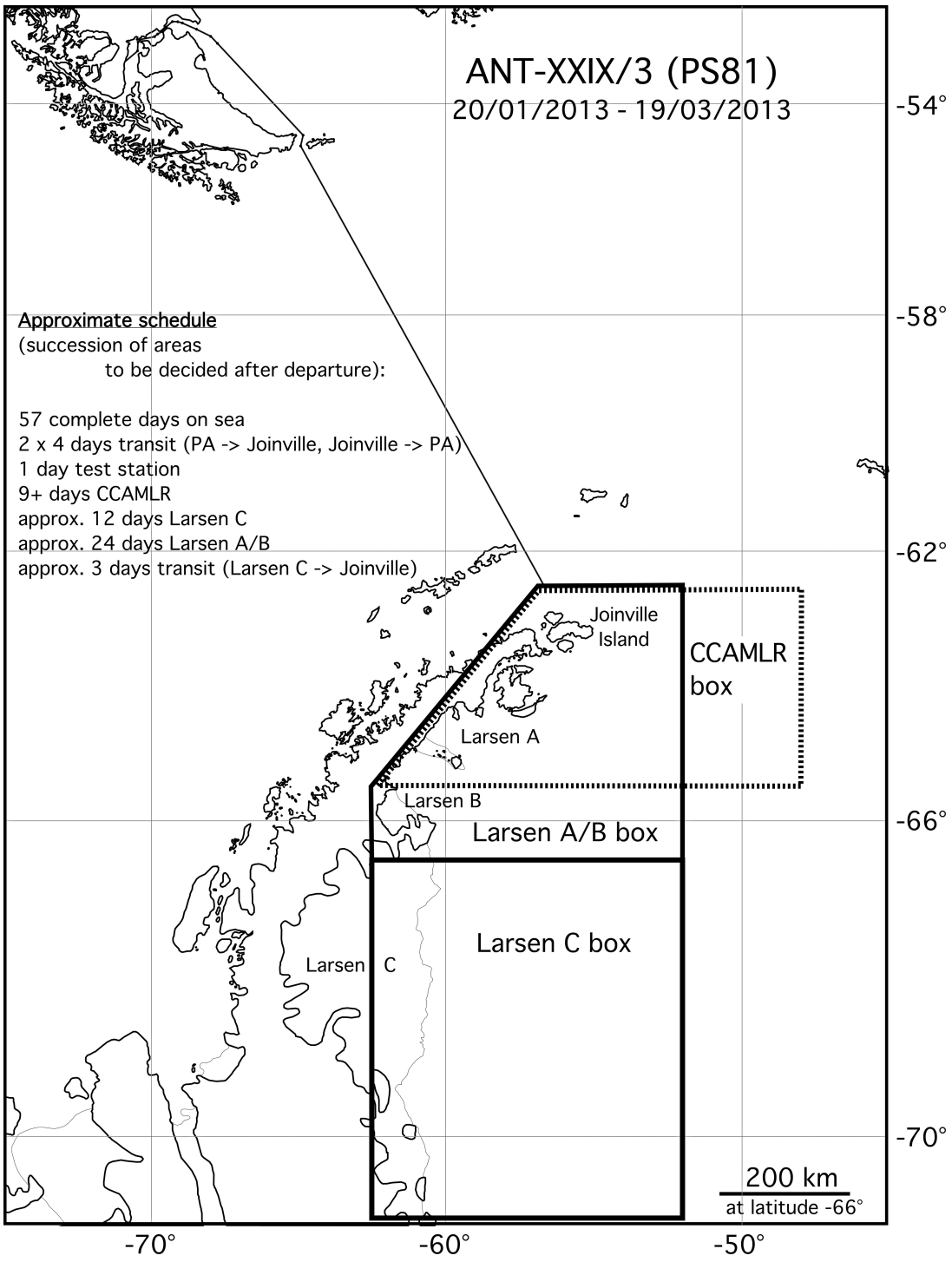

Abb. 1.1: Geplante Fahrtroute der Expedition Polarstern ANT-XXIX/3 und Arbeitsgebiete
Fig. 1.1: Planned cruise track and working areas of Polarstern expedition ANT-XXIX/3

Die wesentlichen Ziele der ökologischen Untersuchungen sind: (1) Nachweise für eine Veränderung oder, alternativ, Aufrechterhaltung der bestehenden Ökosystem-Strukturen und Funktionen nach dem Schelfeiskollaps zu finden. Hierzu sollen die Kernstationen vergangener Reisen wieder beprobt und die Ergebnisse miteinander verglichen werden. (2) Die Repräsentativität unserer bisherigen Kenntnisse über die spezifischen biologischen und physikalischen Bedingungen in dem Larsen A und B Gebieten unter Umweltstress zu verbessern, indem zusätzliche Kernstationen in das Programm aufgenommen werden. (3) Die besonderen Bedingungen dieses Habitates und damit die Belastbarkeit des Antarktischen Ökosystems abzuschätzen, indem neue Referenzstationen beprobt werden. Diese Gebiete sollten möglichst unabhängig von den Larsen-spezifischen Prozessen sein. Die bisher beprobten Referenzstationen waren offensichtlich durch strandende Eisberge geprägt, die vom ehemaligen Larsen A und B Schelfeis kalbten. (4) Einblicke in südlicher gelegene Gebiete zu bekommen, die als Ursprung für die Besiedlung der Larsen A und B Gebiete in Frage kommen, sowie die dortigen Lebensgemeinschaften zu erforschen, die durch fast permanente Meereisbedeckung geprägt sind. Hierfür ist eine eher punktuelle erste Beprobung von einigen Stationen vor dem Larsen C Schelfeis geplant.

Die während ANT-XXIII/8 eingeführte Sammelstrategie wird fortgeführt werden. Alle Probennahmegeräte werden, mit nur wenigen Ausnahmen, auf Kernstationen eingesetzt, die einen gewissen Tiefenbereich auf dem Schelf und verschiedene Sedimente abdecken können, um für ein gewisses Gebiet repräsentativ zu sein. Sie können also auch mehrere Einzel-Stationen umfassen. Das Schwere- bzw. Kastenlot wird in den Larsen A und B Gebieten dort eingesetzt werden, wo es für eine Rekonstruktion der paläo-ökologischen Bedingungen günstig ist. Bildgebende Methoden werden entlang von Transekten für wissenschaftliche Zwecke angewandt und um eine optimale Auswahl von Stellen für die Probennahme zu finden. Meeresbodenvermessungen mit Sedimentprofilierung (Parasound) soll in nicht-kartierten Gebieten um die Kernstationen ebenfalls eine optimale Stationsauswahl sowie eine anspruchsvolle Interpretation der Ergebnisse sichern. Die Hubschrauber-gestützte Bestandsaufnahme von Walen und Robben trägt zu der übergeordneten Fragstellung nach den Einflüssen vom Eis auf die Antarktische Fauna, insbesondere auch im Vergleich zu dem Survey von 2007, bei. Zählungen im Krill/CCAMLR-Gebiet dienen als Referenz für die unter der Küste zu erzielenden Ergebnisse; sie sind auch in das Konzept des Krill-Surveys eingebunden.

Der ozeanografische Schwerpunkt des LASSO-Projektes wird in einem Gebiet mit überwiegend ganzjähriger Meereisbedeckung auf dem Schelf an der Ostseite der Antarktischen Halbinsel bearbeitet. Das Gebiet ist schwer zugänglich und dadurch wenig erforscht, hat aber einen sehr großen Einfluss auf die Ozeanographie und Ökologie im westlichen Weddellmeer. Die beiden großen Abbrüche der nördlichen Schelfeise Larsen A und B, zuletzt in den Jahren 1995 und 2002, haben zu Veränderungen im gesamten Produktionsgebiet dichter Wassermassen geführt, die bis jetzt nur unvollständig vermessen und verstanden sind.

Messreihen hydrographischer Daten von der Nordostspitze der Halbinsel legen nahe, dass eine wichtige Quelle von dichtem Schelfwasser in der Nähe des geplanten Untersuchungsgebietes liegen muss. Als wahrscheinliche Produktionsorte kommen daher nur die Tröge der weggebrochenen Schelfeise Larsen A, B und das gesamte Gebiet vor dem Larsen C Schelfeis in Frage. Eine erste Expedition im Sommer 2004/2005 (ISPOL) zum Larsen C Schelfeis hat diese Vermutung erhärtet. Sehr kalte Temperaturen (< -1.8°C) am Boden in 1480 m Tiefe und hohe Helium^4/Neon-Konzentrationen weisen dabei auf den erhöhten Einfluss von Eisschelfwasser hin. Die ISPOL-Expedition erreichte aufgrund der

sehr starken Meereiskonzentration allerdings nicht den vermuteten Ausstromkanal von dichtem Eisschelfwasser bei etwa 69.5°S und 57°W.

Dieses dichte Wasser vermischt sich beim Absinken am Schelfabhang mit den Wassermassen des Weddellmeeres, wobei es wesentlich zur Belüftung dieser tiefen und tiefsten Wasserschichten beiträgt. Die großräumige Zirkulation innerhalb des Weddellwirbels sorgt nun dafür, dass das Wasser zu großen Teilen das Gebiet des Weddellmeeres an dessen Nordrand im Bereich der Süd-Scotia Bogens verlässt, in den Antarktischen Zirkumpolarstrom eintritt und damit in den tiefen Weltozean eingeschichtet wird. Die Kenntnis der Bildungsraten und Verteilungsmechanismen dieser schweren Schelfwassertypen ist somit von großer Klimarelevanz.

Das CCAMLR Krill-Projekt umfasst eine Studie an der Ostseite der Antarktischen Halbinsel im nördlichen Weddellmeer. Das Untersuchungsgebiet zeichnet sich dadurch aus, dass bisher keine quantitativen Daten zu den Krillbeständen und zur Zooplanktonverteilung aus diesem Ausstromgebiet des Weddellwirbels vorliegen. Andererseits wurde dieses Gebiet von CCAMLR als eines der "Kleinskalingen Managementeinheiten" (Small Scale Management Units, SSMU) definiert, um die Krillbestände und die davon abhängigen Arten nachhaltig und nach dem Vorsorgeansatz bewirtschaften zu können. Mit Hilfe eines standardisierten Surveys sollen Daten zur Krillverbreitung, -biomasse, -demographie und -phenologie (Größenzusammensetzung, Altersaufbau, Reifungszustand der Laicher-Population), zu dessen Populationsdynamik (Wachstum, Sterblichkeit, Larvenentwicklung, Rekrutierung), zur physikalischer Ozeanographie (Wassermassen-Verteilung, Strömungsbild) sowie zur artenmäßigen Zusammensetzung des Zooplanktons gesammelt werden. Routinemäßig kommen das RMT-Planktonnetz und die CTD-Sonde auf ca. 45 Stationen entlang von vier Schnitten zum Einsatz. Eine akustische Aufnahme der Krillbestände erfolgte mit dem SIMRAD EK 60 Mehrfrequenzlot kontinuierlich entlang der Schnitte.

Das Projekt ist Teil einer synoptischen Aufnahme benachbarter Gebiete durch eine Akustik- und Netzprobennahme-Studie, die von drei Ländern durchgeführt wird, von den USA um Elephant Island und den Süd Shetland Inseln, von Norwegen um die Süd Orkney Inseln und von Deutschland im nordwestlichen Ausstromgebiet des Weddellmeeres. Das Projekt dient als Vorstudie für die geplanten Krill-Winteruntersuchungen auf *Polarstern* 2013. Weitere Kooperationen erfolgen mit dem US AMLR Programm, deren Untersuchungen parallel zu diesen Arbeiten im nördlich angrenzenden Gebiet erfolgen werden.

SUMMARY AND ITINERARY

Cruise leg ANT-XXIX/3 will start on 20 January 2013 in Punta Arenas (Chile) and end on 19 March 2013 also in Punta Arenas. Two projects will be carried out on board: “Larsen Shelf Study of the Ocean” (LASSO), a biological-oceanographic study in the Larsen A/B area, and off the Larsen C ice shelf east of the Antarctic Peninsula. These investigations are an integrative part of the new biology programme “Antarctic Thresholds - Ecosystem resilience and Adaptation (AnT-ERA) of the “Scientific Committee on Antarctic Research” (SCAR) and, thus, representing specific research on climate change in the Antarctic. The second project is a krill survey in the north-western Weddell Sea as a contribution to the „Convention on the Conservation of Living Antarctic Resources“ (CCAMLR). The succession of the work in the different areas (Fig. 1.1) will not be decided before departure from Punta Arenas in order to consider the actual sea-ice conditions.

Experts declared in the Antarctic Climate Report (ACCE) that the abrupt disintegration of the Larsen A and B ice shelves, especially in 1995 and 2002 was primarily due to a large-scale regional atmospheric warming. This process will extend to the South at unknown speed; it affects the physical and biological environments.

With this background **the ecological focus of the LASSO-project** is to study the impact of the climate-induced ice-shelf collapse to the marine biological communities on the continental shelf. A first ecological survey had been carried out in 2007 during ANT-XXIII/8. Additional sampling took place during ANT-XXVII/3. Further information especially on paleo-ecological questions comes from the US Antarctic programme LARISSA. It became obvious that the marine ecosystem as a whole is in a transition between a former ice-covered nutrient-poor (oligotrophic) and a “normal” Antarctic stage with highly productivity of algae during the short summer period.

Sediments cover an extremely broad range between bedrock and gravel at the coastal margins of the area and soft sediments in the central depression of the Larsen B bight. Since the ice-shelf disintegration the Larsen B bight experiences a potentially high food supply by a high bottom-near current at its south-eastern „entrance“. *In-situ* primary productivity in the entire area seems to be dependent of an assumed gyre shaped by the bottom topography and the actual ice situation. Different components of the ecosystem apparently respond to the dramatic changes caused by the ice shelf collapses at different speed. Scattered krill concentrations were observed in the water column following the phytoplankton bloom. Mammals were represented by Antarctic minky whales and crabeater seals; penguins were very rare. The benthic meiofauna seems to respond faster than the macrobenthos. The proportion of tentative new species among benthic copepods was extremely high. The megafauna was characterised by deep-sea species and pioneers. Due to the long-term glaciation history and/or the different time elapsed after the ice-shelf collaps considerable differences became visible between Larsen A and B. Faunistic similarities became obvious north and south of the stripe of remaining ice-shelf between Larsen A and B.

The main aims of the ecological survey are: (1) To provide evidence for a shift or, alternatively, persistence in the composition and functioning of the ecosystem after the ice shelf disintegration by repeating the sampling at core stations of previous expeditions and comparing the results. (2) To improve our knowledge on the specific biological and environmental conditions in the Larsen A and B areas under environmental stress and, thus, improve our knowledge on the potential of the Antarctic ecosystem to respond to environmental changes. New stations are to be added to the entire Larsen-study. (3) To evaluate the specific conditions of the Larsen habitats by sampling at new reference stations which are independent of the Larsen-specific environmental processes. Old reference stations of ANT-XXIII/8 seemed to be affected by grounding icebergs, which calved from the former Larsen A and B ice shelves. (4) To provide insights into southerly adjacent communities serving as a potential source for the colonisation of the Larsen A and B areas. In addition, to elucidate what kind of life exists in an area, which is at least potentially shaped by an almost permanent cover of sea ice. A first rather punctual survey is planned off the Larsen C ice shelf.

The survey strategy applied during ANT-XXIII/8 will be continued. All sampling equipment, with few exceptions only, will be deployed at core stations. These can cover a certain depth range on the shelf and various sediments in order to provide representative results for a defined area. Thus, they can comprise more than one single station. A few gravity or box corers will be deployed at selected sites, which allow a reconstruction of the paleo-ecological conditions within the Larsen A and B bights. Imaging methods will be used along transects

for scientific purposes and to find suitable sites for towed and local sampling equipment. Also bathymetry and sediment profiling (Parasound) will be carried out around core-stations to identify suitable sites for ecological sampling and to allow a comprehensive interpretation of the results. The helicopter based mammal survey will contribute to the ice related ecological questions, especially in comparison with results from the 2007 survey. The counting's in the off-shore CCAMLR-krill area will serve as a reference to the observations closer to the coast and will contribute to the concept of the krill survey.

The oceanographic contribution to the LASSO-project will be carried out in the largest perennial ice zone of the Southern Ocean, the eastern shelf of the Antarctic Peninsula. This area is unique among the Weddell Sea ice regions, difficult to access and, as a consequence, sparsely explored although it exerts a major influence on the oceanography and ecology in this region. The disintegration of the Larsen A and B ice shelves in 1995 to 2002 resulted in an alteration of the production of dense shelf water masses over the whole region. Only few data sets exist and the mechanisms of production and mixing of these water masses are not well understood.

Recent hydrographical data from the tip of the Antarctic Peninsula allow the prediction of a nearby source of dense shelf water masses in the troughs of the collapsed Larsen A, B ice shelves and along the whole area in front of Larsen C. A first expedition in summer 2004/2005 (ISPOL) to the Larsen C shelf confirmed the assumption, because very cold temperatures (<-1.8°C) in a water depth of 1,480 m with high helium and neon concentrations were found at the continental shelf break, leading to the increased influence of ice shelf water (ISW). Due to heavy ice conditions the ISPOL-expedition could not reach the speculated ISW outflow channel near 69.5°S and 57°W.

At the continental shelf break these descending dense shelf water types mix with the ambient water masses of the Weddell Sea ventilating the deep and bottom waters. The circulation of the Weddell gyre spreads a certain amount of these fresh water masses through the gaps of the South Scotia arc in the north into the Antarctic Circumpolar Current redistributing these waters into the world ocean. Therefore the understanding of production rates and pathways of these dense shelf water types are of high importance for the global climate.

The CCAMLR krill project introduces a krill and zooplankton study in the north-western Weddell Sea east of the Antarctic Peninsula. Quantitative krill and zooplankton data do not yet exist from this outflow region of the Weddell Gyre and, thus, only hypotheses exist on the origin of the Scotia Sea krill. At the same time the region has been defined by CCAMLR as one of the Small Scale Management Units (SSMU) to allow a precautionary management of the krill stocks and their related consumer species but with a lack of basic data (especially krill biomass) to feed the relevant model to allocate the proportionate biomass (catch limit) to the SSMU. The focus of the studies relates to quantitative aspects of krill biology, distribution, biomass, demography and phenology (size, age, maturity composition), population dynamics (growth, spawning timing, larval development, recruitment), zooplankton species composition and abundance as well as physical oceanography (water mass distribution and current system). Standard equipment will be the large RMT plankton net (to collect adult and larval krill simultaneously), and CTD, which will be deployed at approximately 45 stations along four transects. Continuous recording of krill acoustic targets will be conducted by the SIMRAD EK 60 multi-frequency echo-sounder.
This survey is part of an international synoptic acoustic and net sampling programme for Antarctic krill in adjacent areas, conducted by the US around Elephant Island and the South Shetland Islands, by Norway around the South Orkney Islands, and by Germany in the north-western outflow region of the Weddell Sea. The survey also serves as a pre-study to the planned *Polarstern* krill winter studies in 2013. Further cooperation will be established with

the US AMLR programme, which will carry out at the same time a similar survey in the northerly adjacent area.

2. ECOLOGY (LASSO)

2.1 Megabenthic succession

D. Piepenburg (IPÖ), H. Link (McGILL), A. Segelken-Voigt, A. Böhmer (AWI/UOLD), J. Gutt (AWI)

Objectives

Megabenthic organisms, i.e., those seafloor organisms that are large enough to be visible in seabed images and/or to be caught by towed sampling gear, are of very high ecological significance for the Antarctic shelf ecosystems, as they pronouncedly affect the microtopography of the seabed habitats and do thus exert prime influence on the structure of entire benthic communities. Some species are especially sensitive to environmental change due to their slow growth, specific reproduction mode, high degree of environmental adaptation and narrow physiological tolerances. As a consequence, they can serve as "canaries in the coal-mine", indicating further ecosystem shifts early after ice-shelf disintegration. Previous observations have shown that deep-sea animals, pioneer species, invaders and recruits characterize benthic communities in the Larsen region in the western Weddell Sea. Based on these findings, we will carry out a follow-up field study, the main objectives of which are:

(1) Carry out a survey of megabenthic assemblages being comparable to earlier studies by
- sampling new sites in the Larsen shelf areas A and B to increase the representativeness of the results in terms of the response of benthic fauna to the ice-shelf collapse,
- sampling new sites off the Larsen C ice shelf to assess the ecological impact of the ice-shelf coast and almost permanent sea-ice cover on benthic communities in a comparative analysis,
- sampling reference sites outside the Larsen shelf area formerly covered by ice shelves in order to evaluate the faunal succession in the Larsen A, B and C habitats that happened or will continue to happen, respectively, after the ice-shelf collapses.

(2) Identify spatial distribution patterns at local and regional scales.

(3) Standardise the classification of macro- and megabenthic communities.

The sampling gear used to quantitatively investigate epibenthic megafauna will always be deployed together with other standard equipment, such as CTD, MUC, and bathymetry (where necessary), in order to apply an ecological approach as broad and comprehensive as possible.

Work at sea

Sea-bed imaging will be carried out along transects of about 1 km length by means of the Ocean Floor Observation System (OFOS), equipped with both still-photo and video cameras to investigate the abundance, distribution, composition and diversity of epibenthic megafauna. If feasible, transects are placed such that different benthic habitats (e.g., small-scale slopes, hills, depressions) are covered. At the same sites a drop-camera system will be

deployed to obtain additional high-definition still photos, in order to maximize the overall spatial resolution and standardisation of the study, in terms of the seabed area covered by the imaging survey. Both methods are used for comparison with data gained at other spatial and taxonomic resolution during previous cruises to the Larsen shelf region. Macro- and megabenthic fauna collected from Agassiz trawl catches will be used to aid identification of organisms depicted in the seabed images. In addition, this fauna will be quantitatively classified immediately after the catch according to predefined taxonomic and functional criteria, and these findings will be compared with those originating from the imaging surveys. The combined results will serve as a case study for developing a first general standardisation scheme of Antarctic macro- and megabenthic communities.

Data management

Data and seabed images will be forwarded to open-access data repositories: seabed images to PANGAEA one year after the expedition at the latest, and faunistic data to ANTABif (Antarctic Biodiversity Information Facility; former SCAR-MarBIN) as soon as macro- and megabenthic classification, quantification and identification is finished.

2.2 Dynamics of benthic ecosystem functioning in response to the disintegration of the ice shelves

H. Link (McGILL), D. Piepenburg (IPÖ)

Objectives

Observed changes in benthic community composition and benthic food supply on the Larsen Shelf after the collapse of large portions of the Larsen Ice Shelf raise the question whether this may have influenced benthic ecosystem functioning (BEF). Important BEF components are the degradation of organic matter and associated remineralisation of carbon and inorganic nutrients (Fig. 2.1). Little is known about this issue in polar regions, and even less how these benthic processes have changed and will change in response to the continuing decline of ice shelves off the Antarctic Peninsula. Given the observed shifts in community composition and organic matter sedimentation presently happening in the Larsen area and their probable influence on the organic matter and nutrient fluxes in the benthic boundary layer, we will address three specific research objectives:

1. Quantify benthic boundary fluxes (oxygen, silicic acid, phosphate, nitrogen species) on the Larsen shelf and determine their changes in response to the loss of Larsen A and B ice shelves in comparison to the still intact Larsen C ice shelf.
2. Determine the influence of food quantity and quality and benthic community composition on benthic boundary fluxes in an experimental approach.
3. Evaluate future changes of benthic ecosystem functioning on the Larsen shelf (regions A, B and C) as the ice shelves retreat further.

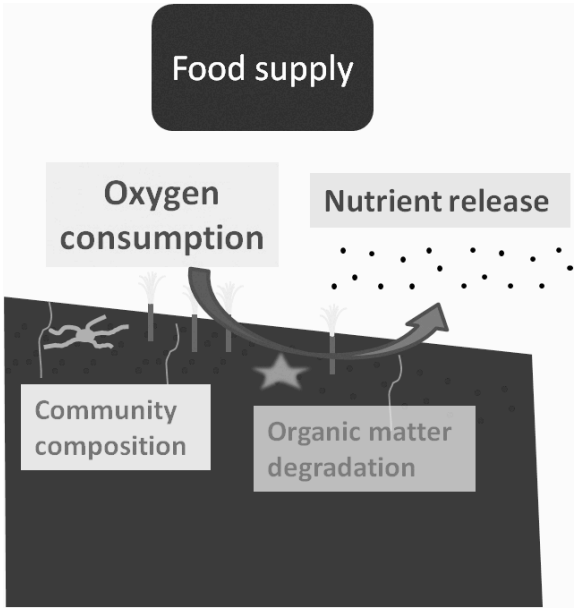

Fig. 2.1: Schematic illustration of benthic ecosystem functioning as used in this project. The process of organic matter degradation and nutrient release is assumed to be influenced by food supply and community composition.

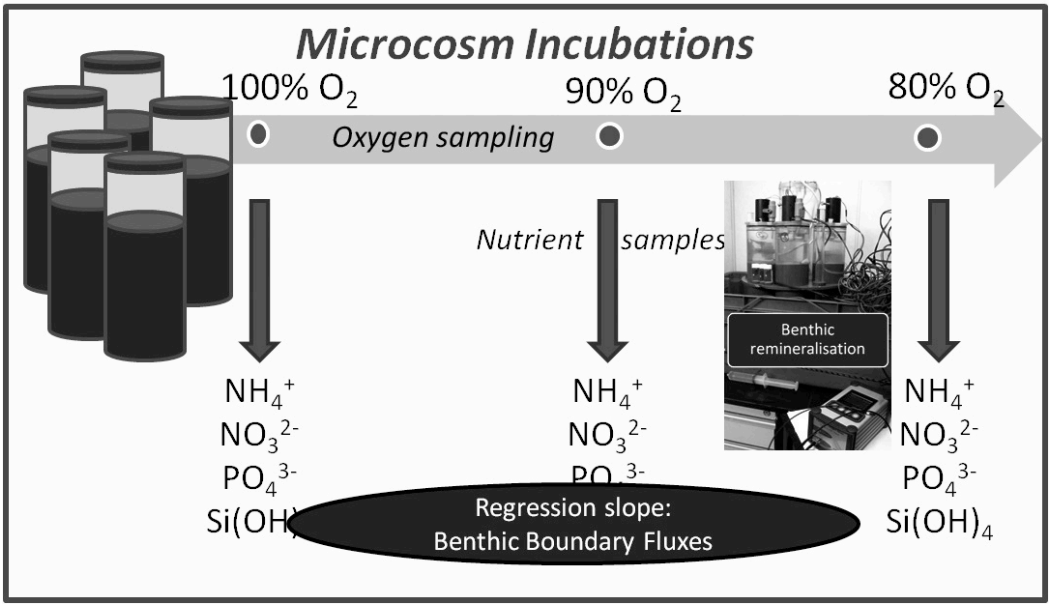

Fig. 2.2: Graphic illustration of the general sampling processing of microcosm incubations during the cruise.

Work at sea

Incubations of sediment cores with inhabiting macrofauna and boundary water (either from the multi-corer or sub-sampled from box cores) will be used to assess benthic carbon, silicic acid, nitrate, ammonium, and phosphate remineralisation (Fig. 2). For this project, we intend to take samples of 5 sediment core replicates per site at four sites each in the 1) Larsen A 2) Larsen B 3) Larsen C and 4) reference area. At two sites in the Larsen B area, additional *in-situ* incubations will be run to determine the effect of *ex-situ* experiments. Macrobenthic organisms for fauna addition experiments will be collected at an appropriate site in the Larsen A/B area from box cores and/or Agassiz trawl catches. At one site in the Larsen C

area (alternatively: at an oligotrophic Larsen B site with macrofauna from Larsen A), 20 core replicates will be taken for fauna-addition and food-addition experiments. Experiments will be conducted in collaboration with the working group of E. Isla.

Data handling

Most data will be obtained through laboratory analyses after the cruise. Processed data will be uploaded to the databases PANGAEA and/or SCAR-MarBIN.

2.3 Biodiversity and pelagic-benthic coupling

E. Isla, N. Teixidò (ICM-CSIC), P. López González, C. M. Martinez (USEV)

Objectives

The marked environmental differences at the sea surface and close to the seabed inspire questions about how the pelagic and benthic ecosystems work and connect between each other, especially in the specific polar conditions of the Larsen A, B and C areas.

The CSIC/USEV group has the common aim of assembling several compartments of the pelagic and benthic systems by combining information from climate, sea ice, settling particulate matter (e.g., plankton detritus, lithogenic debris), the chemical and physical characteristics of the water (e.g., dissolved nutrients, salinity, TºC, current velocity and direction, turbidity), and sediment columns (e.g., grain size, organic contents) and benthic fauna studies (e.g., distribution and community composition).

Ongoing global warming is particularly intense at the Antarctic Peninsula region. As a consequence, glacier retreat and ice shelf collapses during the past decade have altered the local pelagic-benthic coupling characteristics. Recent evidence of such alteration in the region of the collapsed sections A and B of the Larsen ice shelf includes the arrival of fresh organic matter to the seabed and changes in the benthic community composition. The expedition ANT-XXIX/3 will provide the opportunity to follow the changes in this system, first observed in 2007, and to identify the pace at which they are taking place.

The idea is to produce a comprehensive benthic-pelagic coupling interpretation of a still poorly known ecosystem based on earlier and new observations and to enlarge the study area including information from the section C of the Larsen ice shelf, where global warming has been less severe.

Detailed objectives are:

- To detect biodiversity boundaries in the distribution of benthic cnidarians, ophiuroids and pycnogonids.
- To identify dispersal capacities and genetic variability within and among different populations of known hexactinellid sponges.
- To track changes in the organic matter distribution in the sediment column through the analyses of several variables (e.g., protein, lipid, carbohydrates, phytopigments, amino acids, fatty acids and ^{14}C , ^{13}C and ^{15}N).
- To identify local characteristics of particle fluxes and currents.

Work at sea

Water column. Water samples will be taken from Niskin bottles attached to a CTD rosette. CTD profiles will include fluorescence signal data. Water sampling depths will be typically 5 to 6, one 5 m above the seabed (or the deepest possible depth), fluorescence maximum, 5 m below sea surface and two to three more in between the mentioned depths or depths where

something interesting is detected in the CTDF profiles. The set of variables to analyse in water column samples include chlorophyll-a and suspended particles.

Benthos. Agassiz trawl and box corer will be used to collect samples from representative benthic groups. For biodiversity studies, cnidarians and pycnogonids will be relaxed with menthol and fixed in formaldehyde (morphological work) or 96 % ethanol (molecular analysis). In the case of pycnogonids, appendages of the different species and genera will be preserved for molecular studies. For dispersal capacities and genetic variability of hexactinellid sponges tissue samples will be fixed with 96 % ethanol. A minimum of 10 individuals will be collected from each station.

Sediment. Sediment cores will be recovered with a giant box corer or a MUC. They will be subsampled on board in slices 0.5 cm to 2 cm thick. Experiments of sediment incubation will be performed, which include dissolved oxygen and ammonium measurements. A conical SMT 234 sediment trap will be moored 20 m above the seabed (mas) coupled to a current meter Aanderaa RCM9 located 8 mas. Operating time of these instruments will be decided on board.

Expected results

It is expected to recover a set of samples including benthic animals, sediment, particle fluxes and information on water current velocity and direction. The samples will be analysed back in the participating institutions; however, dissolved oxygen and ammonium concentrations in sediment incubation experiments will be developed on board.

Data management

All the data generated from this expedition will be included in the Spanish Polar Database located in the Spanish Polar Committee's National Polar Data Center, http://hielo.igme.es/index.php/en/.

2.4 Paleo-ecology

E. Domack (HC-NY), S. Thomas (UHAWAII)

Objectives

The objectives are to expand and develop an improved paleoenvironmental data base for conditions in the region of the Larsen Ice shelf over time frames that extend from a few hundred to thousands of years. This work will build upon prior collaboration between USAP and the AWI in both marine geology and physical oceanography. The work is part of an existing NSF award to E. Domack (Hamilton College).

Work at sea

Sediment Cores: I intend to collect about 10 3 m long boxcores within the Larsen B (and Larsen C if possible) region to help the ecosystems group in placing biological observations into a stratigraphic (paleoenvironmental) context. The cores sites will be selected in such a way as to complement the existing core coverage and to make most efficient use of available wire time during transits between biological stations

Coral Sampling: I intend to collect, if possible, large specimens of deep water corals known to exist in the area off Cape Framnes. This will include but not be limited to specimens of the genus *Errina* sp.

Multibeam and Parasound Coverage: I will assist the chief scientist and bathymetry staff in the selection and processing of multibeam and Parasound coverage in areas of the study area to complement existing data from previous cruise of USAP and AWI vessels (data to be provided prior to cruise).

Mooring Recovery: I will assist with the recovery of two oceanographic moorings that have been placed in the region by previous cruises of the *NB Palmer*. I will handle and download data from mooring instruments and process and store sample tubes from sediment traps.

Expected results

Results will establish the timing of ice sheet to ice shelf transitions from across the inner shelf of the NW Weddell Sea, as based upon age dating of the sedimentary sequences. The down core characterization of organic matter (C and N and their isotopic values) will also help establish changes in organic matter sourcing and nutrient characterization in the changing succession of facies, from ice shelf to open marine. Isotopic and radiocarbon records from the corals will help define the evolution of water masses within the embayment-- from ice shelf to open marine settings-- and the antiquity of reservoir properties of the Weddell Sea outflow over time. Mooring data will be useful in understanding seasonal and interannual variations in water mass circulation within the embayment, at least as far back as 2010. The multibeam and Parasound data will help elucidate the nature of glacial recession in tandem with rising eustatic sea levels approximately 12,000 years ago.

Data management

Archives of sediment cores will be transported to AWI for curation under the direction of Dr. Gerhard Kuhn. All core descriptions, photographs, and sample logs will be posted to AWI for curation in the data library. Sub samples and flat slab archives will be sent to Hamilton College. Coral specimens will be sent to Hamilton College for subsampling and processing for radiocarbon analysis and then sent to AWI for permanent curation. Physical oceanographic data will be shared with AWI and ANT-XXIX/3 science staff but processed and interpreted under the supervision of Dr. Arnold Gordon and Mr. Bruce Huber at Lamont Doherty Earth Observatory. Sediment archives from sediment traps will be sent to Hamilton College for processing and archiving. Multibeam data will be processed and shared with LARISSA (USAP) investigators but done so under the direction of the bathymetry office at AWI. All analytical results from cores or material collected from this collaboration will be shared with the entire ANT-XXIX/3 science staff in a timely fashion.

2.5 Prosperity and limitation of sponge fauna and associated organisms

D. Janussen (FS), D. Kersken (RUB)

Objectives

Major parts of the benthic communities on the Antarctic shelf are dominated by siliceous sponges, which –both *in vivo* and *post mortem*— structure the sea floor and provide habitats for other organisms. Our investigations so far have shown that the abundant Antarctic sponges comprise about 50 species from 30 genera. Some of these show considerable morphological variation and transitional traits that may indicate species complexes, ongoing speciation, hybridization, or a combination (e.g., molecular investigations show poor resolution of the assumed *Rossella racovitzae* complex). First evaluations of macro-, meio-

fauna and microbial assemblages from selected sponge species (e.g., from the genera *Rossella* and *Mycale*) revealed different endobiotic communities. This project is designed to analyse the impact of climate change on the diversity of sponges within Antarctic shelf communities and their response to the disintegration of ice-shelves. Detailed faunistic comparisons will be done between the sponge faunas of the Larsen ABC areas including stations already sampled during ANT-XXIII/8 and reference stations. Assumed speciation processes and colonization of the Larsen shelves by pioneer and deep-sea sponge taxa will be tested by comparative morphological and molecular methods as well as parallel investigations of the sponge in-fauna. Together with cooperation partners (AG J. Gutt) ecological successions will be investigated by qualitative and semi-quantitative evaluation of ROV transects.

Crucial questions to be targeted are:

- How does the sponge fauna of Larsen ABC differ from reference stations outside the formerly ice-covered shelf areas, and from that of the eastern Weddell Sea?
- Do we find signs of re-colonization or dynamic developments in the former Larsen ice-shelf areas, what role do deep-sea and pioneer sponges play in this context?
- What is the influence of physical environmental factors like currents, sedimentation, substrates and disturbance through iceberg scouring on the sponge settlement?
- Is the impoverished sponge community, including abyssal species, a relic of oligotrophic biotopes in the former Larsen B ice-shelf area, or is it an ongoing colonization of the shelf by deep-sea taxa? Alternatively, is this fauna a characteristic of an oligotrophic part of the south-western Weddell Sea, which is ice-covered most of the year?

Work at sea

Collection and documentation of the sponge fauna will be carried out by various gears, mainly AGT, but also MUC. Subsampling will be done of many individuals of investigated species for genetics, for histology and transmission electron microscopy. Entire specimens or larger samples of selected sponges will be fixed in formalin solution to pick out endobionts later. Small clean sponge samples will be rinsed with sterile filtered seawater and fixed for bacterial screening. Samples will be frozen at –80°C and –20°C for lipids and stable isotopes analysis. Microbial screening and isotope analysis should be done also for sediment samples, which will be frozen. Seawater samples (potentially bottom water) will be obtained from the CTD-rosette and passed through a microfiltration on board, in order to isolate the microbes and compare them with those found within the sponges. Furthermore, where possible, participation in the taxonomic analysis of underwater videos is intended.

Data management

Sponges collected will be catalogued in the SESAM Database (Senckenberg Sammlungsmanagement), which provides all data into GBIF and EurOBIS. Species will be reported to the Register of Antarctic Marine Species (RAMS). Genetic sequences will be submitted to GenBank.

2.6 Echinoids – biodiversity and place in ecological succession

Ch. De Ridder, Ph. Dubois (ULB), B. David (UBOU)

Objectives

About 10 % of known echinoid species occur south of the Polar Front, making the Southern Ocean a worldwide 'spot' for echinoids. They are distributed into nine families and seven orders and count epifaunal and endofaunal species. Antarctic echinoids belong to numerous ecological guilds, display various feeding strategies and reproduction modes, and are widely distributed throughout the Southern Ocean. They are therefore highly prone to participate to initial colonization and ecological successions in disturbed areas. In 2007, during ANT-XXIII/8, three "pioneer" species were recorded in Larsen A/B areas: *Sterechinus antarcticus, S. neumayeri* and *Notocidaris mortenseni.* Their reproduction mode and feeding behaviour support their putative colonizing aptitudes. The two *Sterechinus* species are broadcasters and omnivorous; they also harbour an opportunistic transient digestive microflora. *N. mortenseni* seems to be a broadcaster, and is a generalist carnivorous feeding; it apparently lacks a digestive microflora. In addition, because their spines provide microhabitats for a wide range of sessile organisms, pencil sea-urchins (Cidaridae) can be considered as "key" contributors to local biodiversity. Data from ANT-XXIII/8 has shown that the fauna fixed on spines of *N. mortenseni* display an "unusual" diversity as more than 80 % of "housed" taxa were shared with sessile communities present on stones of the sea bottom (Hardy et al 2011). This contrasts with the pattern observed outside the Larsen areas where sessile fauna fixed on cidaroids and stones largely differed between each other (Hétérier et al 2008).

ANT-XXIX/3 provides the opportunity to undertake spatial and temporal comparisons of benthic diversity levels and patterns between disturbed areas of the Weddell Sea and to decipher the underpinning colonization processes. New species occurrence data in Larsen A/B, the presence of pioneer species off Larsen C (and in iceberg-scoured areas) and features of the sessile fauna fixed on cidaroids will be compared with 2007 data to identify community successions. Biological features of colonizers will also be investigated.

Biodiversity. Species inventories in the Larsen areas will be completed so as to identify colonizers and community successions. The time lag between the respective ice-shelf collapses of different Larsen will allow to trace a rather complete time series, and build a comprehensive view of the colonization of new areas by echinoids and their symbionts. The newly collected data will be merged with former sets from the same area and Western Antarctic as well as Magellanic regions in order to improve the appraisal of biogeographic relationships between southern South America and West Antarctica.

Larsen colonizers. Processes underpinning biodiversity patterns will be investigated at inter-specific and intra-specific levels. The first objective is interspecific comparison to determine if colonization ability is linked to particular biological features and if colonizing species show a higher plasticity compared to non-colonizing species. To answer these questions, we will identify reproductive and feeding habits (gut contents, bacterial microflora, ratios of stable isotopes), and measure a suite of physiological parameters and their variability for species occurring in and outside Larsen stations. These will include: (1) metabolic rate (oxygen consumption, production of fecal pellets and food uptake); (2) ammonium excretion (samples collected in respiratory chambers at the end of oxygen measures); (3) scope for growth; (4) acid-base and capnic status of the coelomic fluid; (5) protein synthesis activity (samples collected for determination of RNA/DNA ratio). Second objective is intraspecific comparison to determine to what extent colonizing individuals are acclimated to Larsen areas, e.g. showing extreme values for the measured parameters (i.e. if a restricted subset of the

species variability is expressed). The strategy will rely on intraspecific comparisons of a significant number of individuals occurring in and outside the Larsen areas. Particularities of feeding processes and physiological parameters will be investigated. Morphometric and possibly biomechanic comparisons of skeleton characteristics will also be carried out.

Ecological role of ectosymbionts. Ectosymbiotic communities associated to cidaroids act as ecological engineers and contribute to the local biodiversity in Larsen areas. The objective is to check if, seven years after the first study, the pioneer fauna fixed on the sea bottom (mostly on stones) is still similar to that of cidaroid ectosymbiotic communities. Potential departures from the 2007 situation will be investigated in order to characterize secondary successions in ectosymbiotic communities. Cidaroid and surrounding sessile communities will be compared too. Local diversity of the sessile fauna will be studied inside and outside Larsen areas by comparing stones and cidaroids. Comparisons will not be restricted to stones, but the study will also include comparisons with the whole benthic fauna collected at the same stations. The objective focusing on symbiotic holothurians is to examine the effect of brooding on dispersal through comparisons of the genetic structures (microsatellites) of hierarchized infrapopulations of *Echinopsolus acanthocola* (a symbiotic holothuroid specific of cidaroids). Complementary anatomical and behavioural observations will be done on board in order to complete previous results on the brooding process and life history of this species.

Work at sea

As a component of the megabenthos, echinoids will be sampled using the Agassiz trawl. Some observations will be done on living animals. Further studies (anatomical, biochemical, stable isotopes, genetic) will be realized in Brussels and Dijon laboratories, on samples kept in 70 % or 95 % ethanol or frozen in liquid nitrogen and stored at -80°C. Sediment will be sampled at some stations and frozen (-80°C). Bottom seawater temperature, salinity, pH and alkalinity will also be necessary to interpret physiological data.

Data management

Data on biodiversity will be integrated into the SCAR-Marine Biodiversity Information Network (SCAR-MarBIN) and accessible to the international scientific community. This will complete a long series of previous contributions (David et al 2005a,b).

References

David B, Chone T, Mooi R, De Ridder C (2005a). Antarctic echinoidea. Synopses of the Antarctic benthos, vol. 10. Koeltz Scientific Books, Königstein. 274pp.

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Hétérier V, David B, De Ridder C, Rigaud T (2008**)**. Ectosymbiosis is a critical factor in the local benthic biodiversity of the Antarctic deep sea. Marine Ecology Progress Series, 364, 67–76.

2.7 Crinoids, starfish and tunicates – biodiversity and place in ecological succession

M. Eléaume (MNHN)

Objectives

Crinoids, starfish and tunicates constitute a conspicuous component of the Antarctic shelf mega-epibenthos. A few species, like the *Promachocrinus kerguelensis*, are locally very abundant. About 40 species of crinoids, 107 species of tunicates and 252 species of starfishes occur in the Southern Ocean. In the last few years, several new species of crinoids have been or are being described (i.e. *Ptilocrinus amezianeae*, *Feracrinus* nsp, *Thalassometra* nsp, *Pentametrocrinus* nsp, *Hyocrinus* nsp) (Eléaume et al 2011). Genetic studies also have contributed to our knowledge of the diversity of crinoids in the Southern Ocean and suggest that cryptic species are still unrecognized within *P. kerguelensis*, *Notocrinus virilis*, *N. mortenseni*, *Isometra graminea*, and *I. vivipara* (Hemery et al 2012). Our preliminary results on 18 species of Southern Ocean starfish yielded similar results, revealing unexpected genetic diversity. Moreover, we found that populations of brooding species, because brooders don't disperse much, are geographically structured and may be used as signatures of past glacial refugia. Both crinoids and starfish have brooding and broadcasting representatives and may be used to test the existence of such refugia all around the Antarctic shelf. Brooders can also be used to assess the geographic origin of the colonizing specimens and therefore help identify the source populations of the Larsen colonization.

Our results suggest that the crinoid and starfish biodiversity is only partially known and need to be further explored. In addition, because many taxa previously thought to be one species are now believed to be composed of complexes of cryptic species, the paradigm of their circumpolar distribution has to be revised. More generally, the study of genetic variation helps understand with some precision the geographic distribution and past history of benthic organisms. Our goal is to better understand: (1) the patterns of biodiversity; (2) the genetic and geographic structure within species between population of target organisms; and (3) the past history of crinoid and starfish in the Southern Ocean.

Exploration of biodiversity. Crinoid, starfish and tunicate specimens will be collected in the Larsen A/B areas and off Larsen C. Taxonomic studies will help assess the morphological and genetic diversity represented in the Larsen areas. This diversity will be compared to other shelf and deep areas around the continent.

Phylogeography. Crinoid and starfish will be sampled at population level in order to explore the intraspecific variability of abundant species. This dataset will be used to assess the geographical origin of colonizing populations using highly structured populations (i.e. brooders such as *Isometra* spp or *Notocrinus* spp), test the presence of cryptic complexes within species and assess the circumpolar paradigm.

Biogeography. The origin of the Antarctic shelf fauna is diverse and has to be tested on each individual species. We recently found that the crinoid *Dumetocrinus antarcticus* that occurs in the Larsen area shows an unexpected genetic variability correlated with morphological traits and geographical origin suggesting that two species may exist: one on the eastern side of the Peninsula and the other on the western side therefore demonstrating that the Scotia Arc may act as an ecological barrier for some taxa.

Work at sea

As a component of the megabenthos, crinoids, starfish and tunicates will be sampled using the Agassiz trawl. Specimens will be preserved in 80 % ethanol. Tissue samples will be taken and preserved in 96 % ethanol for DNA extraction and amplification.

Data management

All data sets will be accessible to the international scientific community. Taxonomic data will be integrated into the SCAR-Marine Biodiversity Information Network (SCAR-MarBIN), in the GBIF and INVMAR. The genetic data will be deposited in BOLD and GenBank.

References

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Hemery LG, Eléaume M, Roussel V, Améziane N, Gallut C, Steinke D, Cruaud C, Couloux A, Wilson NG (2012). Comprehensive sampling reveals circumpolarity and sympatry in seven mitochondrial lineages of the Southern Ocean crinoid species *Promachocrinus kerguelensis* (Echinodermata), Molecular Ecology, doi: 10.1111/j.1365-294X.2012.05512.x

2.8 Taxocoenoses of amphipod crustaceans

C. d'Udekem d'Acoz, M. Verheye (RBINS)

Objectives

With over 850 species, amphipods are the most diverse macrobenthic taxon in the Southern Ocean. Recent studies have shown that many species are inadequately described, and that many alleged 'well-known species' consist of complexes of (pseudo-) cryptic species. The high species richness of amphipods and their dominant role in Antarctic ecosystems (expected to undergo major anthropogenic alterations in the near future) justifies in depth systematic, phylogeographic and ecological studies. Current researches at the Royal Belgian Institute of Natural Sciences (RBINS) are focused on their morphological and molecular systematics and will benefit from material of ANT-XXIX/3. The project has 5 objectives:

- To document and compare the traits of Larsen amphipod taxocoenoses,
- to contribute to the description of morphological and molecular biodiversity of Antarctic amphipods of 3 superfamilies (Eusiroidea, Liljeborgioidea, Lysianassoidea),
- to contribute to the description of morphological and molecular biodiversity of Antarctic isopod and mysid crustaceans and polynoid polychaetes,
- to carry out a faunistic inventory of the bryozoans of the Larsen areas,
- to provide a new dataset of distributional, ecological and photographic information on Antarctic amphipods.

Work at sea

At various stations, material of relevant organisms will be collected with trawling gears and baited traps. The specimens will be sorted, photographed, and identified on board whenever possible. A large part of the crustacean material will be fixed in pre-chilled absolute ethanol for DNA studies and then stored in the freezer at –20°C, for further DNA analyses. Other samples will be fixed in denatured ethanol at 70° or 96°.

Expected results

New distributional data will be obtained for crustaceans, bryozoans and polynoid polychaetes, and new species will be described. The distributional data will contribute to the characterisation of the benthic communities of the Larsen area. DNA sequences obtained from collected specimens will improve the knowledge on the phylogeny and phylogeography of amphipods, mysids and isopods.

Data management

Amphipods studied by C. d'Udekem, C. Havermans, M. Verheye (RBINS) and deposited at RBINS; isopods and mysids by C. Held (AWI) and deposited at Zoological Museum of Hamburg; bryozoans by H. De Blauwe (external collaborator at RBINS) and deposited at RBINS; polychaete by R. Barnich (FS, Frankfurt a.M.) and deposited in the same Institute. Data repository of biogeographic data to be processed by B. Danis (RBINS): SCAR-MarBIN database (www.scarmarbin.be/).

2.9 Symbioses

M. C. Alvaro (MNA), A. Barco (UROMA)

Objectives

Marine 'partnerships' or 'symbiotic' associations have only recently been recognized to play a very important role in shaping marine communities, since they may affect their structure and that of food webs to an extent as important as predation or physical disturbance. In recent years a growing body of evidence highlighted that marine symbiotic associations do exist in Antarctica, although rarely documented. These interactions involve several species of molluscs and polychaetes, which act as parasites or kleptocommensals of several classes of echinoderms.

Within the LASSO project, a special focus will be placed on symbiotic interactions with the aim to understand if differences, in terms of typology/abundance of the associations, do exist between former ice-covered areas (oligotrophic) and the surrounding areas, or if there is any 'recolonization' process in act. The partners of the associations will be studied from an ecological and phylogenetic point of view. This latter point will be achieved by using molecular techniques and by comparing the obtained sequences (e.g. Cox I gene) with those already available from other research projects.

Work at sea

Samples will be obtained by means of towed sampling gears, which will be deployed at core stations according to the established sampling grid. When found, the partners of the association will be immediately placed in seawater and studied, if possible, in their behaviour. Subsamples of tissue for molecular studies will then be prepared and properly stored for further analyses at the end of the cruise. All species will be preserved in ethanol.

Expected results

Possibly undescribed typologies of association will be encountered in the areas formerly covered by the ice shelves. If already known associations will be found, molecular data will allow to understand how isolated have been the partners of the associations and, possibly, their biogeographical origin.

Data management

Voucher species of all the relevant material (i.e. the specimens from which molecular sequences will be obtained) will be deposited in official institutions as the Italian National Antarctic Museum (MNA) and/or in other institution indicated by the Principal Investigator. Sequences will be deposited in BOLD and GenBank following the standard protocols.

2.10 Succession in meiobenthic communities with a special focus on free-living nematodes and harpacticoid copepods

F. Hauquier (UGENT), G. Veit-Köhler (FS-DZMB)

Objectives

Meiofauna are small benthic animals with a body size between 1 mm and 32 µm. They are found everywhere in the oceans' sediments and are normally characterized by a great diversity. However, little is known about benthic meiofaunal communities living beneath the Antarctic ice shelves. Is a suggested lower productivity limiting diversity in those environments? Or is meiofaunal diversity in these shallow areas comparable to the nutrient-poor but highly diverse deep-sea plains? The disintegration of Larsen A and B (mainly 1995 and 2002) gave way to study benthic areas formerly covered by ice shelves for several thousand years, and to compare these with long-term uncovered and probably more productive reference areas.

Our main goal is to investigate the succession of meiobenthic communities in the Larsen A and B areas, focusing on the two major components of the meiofauna: the nematodes and the copepods. The samples taken during the expedition ANT-XXIII/8 in January 2007 lead to the following results: Among the Larsen B stations meiofaunal density was lowest at the food-poor innermost stations and comparable to deep-sea densities (Rose et al submitted). A first benchmark study on nematodes showed that the communities near the former Larsen B ice-shelf margin differed from those in the innermost parts in terms of diversity and composition (Raes et al 2010). The same was true for the family composition of harpacticoid copepods (Rose unpublished data).

In 2011, during ANT-XXVII/3, all stations from this first study were repeated in order to see how things have developed since then. During ANT-XXIX/3, another set of samples will be collected for meiofauna analysis; this time complemented by samples from Larsen C. Our results will enhance the understanding of meiofaunal community development and colonisation speed after changes in environmental conditions due to catastrophic events caused by regional climate warming.

Work at sea

The 'core' stations sampled in Larsen A & B during ANT-XXIII/8 and ANT-XXVII/3 are to be repeated with a multicorer (MUC; 12 tubes; inner diameter of 57 mm). Replicative sampling (5 replicate MUC deployments) is important in order to get statistically meaningful results. These samples will be complemented by reference samples and Larsen C samples. The MUC cores will be sliced till 5 cm sediment depth into 1 cm layers, and samples will be fixed in 4-8 % buffered formalin for meiofauna, nematode and copepod analysis. Additionally, small subsamples will be collected to assess grain size, organic C/N content and pigments. These will be stored at freezing temperatures. Further, sediment samples will be stored

frozen for carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope analyses in order to investigate differences in the productive regimes between the Larsen A, B and C regions.

Data management

All data will be stored in the Marine Data Archive (MDA) developed in 2008 by the Flanders Marine Institute (VLIZ). After publication, data will be made publically available via MDA or SCAR-MarBIN.

References

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2.11 Marine mammal survey

K.-H. Kock (vTI-SF), H. Feindt-Herr, V. Peschko (TiHo-ITAW)

Objectives

Knowledge on the distribution, density and abundance of whales in the Southern Ocean is rather limited. Especially in pack-ice regions little research has been conducted, as only few vessels can penetrate into the ice. By means of an aerial whale sighting survey following standard line-transect distance sampling methodology, our project aims to contribute to solid base line data on whale occurrence and abundance in the Southern Ocean. Relationships between sea-ice and whale distribution shall be investigated as well as relationships between their occurrence and krill density. Results from the Larsen A/B area shall be compared to results of a previous study in the same area in 2006/07 during ANT-XXIII/8.

Work at sea

We will conduct aerial whale sighting surveys whenever sighting and weather conditions permit and the helicopters are available. Our survey team during each flight will consist of three people, two observers and one data recorder. Throughout each flight, sighting data and data on environmental conditions will be logged directly onto a computer connected to a GPS. During transit of *Polarstern*, surveys will be flown in an *ad-hoc* manner, i.e. whenever we find favourable conditions to survey, we will plan a flight and carry it out immediately. In the area of Larsen A/B we will conduct a pre-planned survey following a set of pre-designed transect lines to cover the area in a representative way. Similarly, we will follow a pre-planned survey design during the CCAMLR-krill survey, this time in close temporal and spatial coordination with the krill survey design. Thereby we want to allow for a close comparison and evaluation of krill and whale occurrence during analysis.

Expected results

Firstly, our data will contribute to data sets used for the assessment of whale populations in the Southern Ocean. Along with distributional analyses of species occurrence, distance sampling evaluation will contribute to abundance estimation of species, e.g. the Antarctic minke whale (*Balaenoptera bonarensis)*, which is still being hunted. Relationships between pack-ice density and whale occurrence shall be evaluated and help understanding the impact sea-ice has on species-specific distribution, e.g., of the Antarctic minke whale. Likewise, data

obtained during the CCAMLR-survey shall shed further light on whale-krill relationships and enable fine-scale investigations of whale habitat use. A comparison with results from our first marine mammal survey in the area of Larsen A/B in 2006/07 including seals will reveal similarities or changes of marine mammal occurrence and distribution within the area of the Larsen A/B iceshelf collapse.

Data management

Data will be stored in the Antarctic aerial survey database of the ITAW and can be made available from there on demand.

2.12 Regional bathymetry

B. Dorschel, D. Damaske (AWI)

Objectives

Precise depth measurements are necessary to provide seafloor morphology and structure as basic information for a variety of marine sciences. For the pelagic ecosystem depressions are a key feature that causes hydrographic gyres in which organic material accumulates in the water column. At such sites soft sediments can be expected at the sea-floor, whilst slopes and elevations are mostly characterised by coarser sediments including gravel and bedrock, both determine significantly the existence of different benthic communities. Such bathymetric structures also shape local currents and can be responsible for deep-bottom water formation and its fade. The eastern margin of the Antarctic Peninsula is bathymetrically sparsely surveyed. The older data suffer from low depth sounding quality and from bad navigation in high latitudes as well as bad weather conditions. Thus, the accuracy of the existing bathymetric data sets (GEBCO Sheets 5.16, 97.1 and 97.2, for example) is not sufficient for detailed scientific investigations. This is especially true for a morphological interpretation of the seafloor concerning glacial-induced structures, which might provide information on the drainage pattern of the Larsen ice shelves.

Work at sea

The major scientific bathymetric work will be performed in the area of the former Larsen A and B ice shelves. Depending on the biological survey, gaps in the existing bathymetric maps will be filled and additional measurements will be carried out in areas, especially where new core stations will be sampled. Water sound velocity profiles must be measured in the survey area. This method was used successfully in the area of the Hakon Mosby Mud Volcano for the determination of a high resolution Digital Terrain Model.

The qualitative and quantitative results of the multibeam survey in this area depend on the sea ice coverage. The ship speed and the orientation of the survey grid have to be adapted to the sea ice situation. An alternative working area around Joinville Island is planned in case of too difficult sea-ice conditions in the Larsen A and B areas as well as off Larsen C. Since multi-beam surveys with Hydrosweep DS-3 will be carried out by only two operators, temporarily the system has to be operated unattended. Data will be processed on board, integrated in existing data sets and bathymetric working maps will be prepared.

Data management

In addition to specific scientific questions all multi-beam data collected during the expedition will supplement the existing bathymetric data base for the Southern Ocean. On basis of the

collected data, existing charts like the GEBCO and IBCSO (International Bathymetric Chart of the Southern Ocean) will be updated.

3. OCEANOGRAPHY AND TRACER MEASUREMENTS (LASSO)

3.1 Oceanography: Observation of dense shelf and bottom waters in front of the Larsen A, B, and C ice shelves

M. Schröder, A. Wisotzki, Y. Nakayama, M. Rücker van Caspel,
S. Reinlein (AWI), T. Albrecht, M. Mengel (PIK)

Objectives

Only very few hydrographic observations on the eastern side of the Antarctic Peninsula exist in front of the 3 (former) Larsen ice shelves A, B, and C. Near-bottom variability of waters measured in the north-western Weddell Sea near the tip of the Antarctic Peninsula reveal the intermittent behaviour of cold-water sources on the nearby shelf areas off Larsen A/B and C with consequences for the water mass export across the South Scotia Ridge into the world ocean. The physical environment on the Larsen shelf is characterised by cold shelf waters, which -under specific circumstances- are able to form the precursors of Antarctic Bottom Water (AABW), Weddell Sea Deep and Bottom Water (WSDW and WSBW). They are produced by interaction of warmer mid-depth and surface water masses with different shelf water types. The latter are partly generated by interaction with the Antarctic ice shelves and are, apparently, extremely sensitive to climate variability, which affects basal melt rates or even might induce ice shelf decay.

Additional changes in sea ice cover also modify the salinity structure of the water column underneath with implications to the overall density structure and impact on the composition of water masses. This will lead to a modification of the uptake and storage of atmospheric gases like the climate relevant anthropogenic carbon as well as a changing Meridional Overturning Circulation. The complex mechanism of AABW formation in the western Weddell Sea in relation to the collapsed Larsen Ice Shelf and possible feed backs are in an early state of investigation.

High Salinity Shelf Water (HSSW) is formed by brine rejection during sea ice production on the broad shelf regions of the south-western Weddell Sea during winter. HSSW can mix with Warm Deep Water (WDW) and Winter Water (WW), to produce Weddell Sea Bottom Water (WSBW), HSSW, which flows into the caverns below the ice shelves, melts the ice from below or at its front. The blend of glacial melt water and HSSW, called Ice Shelf Water (ISW, with θ below surface freezing temperature), mixes further with WDW to produce WSBW as well. Further mixing with ambient water masses or additions from external sources renews Weddell Sea Deep Water.

In front of Larsen A/B the hydrographic data from the north-western Weddell Sea continental shelf between 1985 and 2006 showed a freshening of the whole water column of 0.1. In addition, a thermal front develops during summer at around 64°S. Possible causes for these alterations are changes in the circulation pattern on the shelf, enhanced melting at the base of the Larsen Ice Shelf, and an increased number of grounded icebergs.

One aim of the ISPOL experiment (2004/2005) was to find evidence for deep and bottom water formation in the hardly accessible area adjacent to Larsen C. Previous studies also suggested that the western Weddell Sea has to be considered as a distinct source for Weddell Sea Bottom Water (WSBW). The hydrographic and tracer observations (noble gas and CFC measurements carried out by the IUP Bremen) obtained during ISPOL revealed recently ventilated bottom water which contains significant fractions of glacial melt water, most definitely originating from the Larsen Ice Shelf.

It is speculative that the loss of 5,000 km^2 or 5 % of the total Larsen Ice Shelf would imply a reduction of bottom water formation in the western Weddell Sea. It is also feasible that a larger ice shelf free area, which allows more sea ice to grow and HSSW and, subsequent, WSBW to form, could compensate the glacial melt water induced WSBW formation. But this speculation contradicts recent observations where a freshening on the shelf north of Larsen is observed.

Some main objectives for the upcoming cruise are:
Larsen A/B:

- How much dense shelf waters are formed in winter in the former Larsen A/B area? Measurements carried out in 2006 indicate that the Larsen A and B inner-shelf depressions (Gilbert et al 2003) provide a reservoir of cold/saline water which is produced since the disintegration of the ice shelves exposed more ocean surface to the cold atmosphere.
- Identification of the importance of this water masses for deep water formation variability.
- What are the pathways of shelf waters, which form the deep waters of the Bransfield Strait central basin?

Larsen C:
Here the major objective is a systematic physical oceanographic survey in an area where during the ISPOL 2004/2005 expeditions very cold water was found. The new data should reveal the advection of dense water from the local Larsen C source to the shelf break and into the Weddell Sea abyss. This water type will override the more southerly formed (e.g. Filchner) sources and will therefore be able to leave the Weddell basin into the world ocean forming the lower branch of the global thermohaline circulation. This scientific approach demands an as close as possible hydrographic sampling of the local Larsen source. Together with the analysis of tracer compositions to determine the mixing ratios of the contributing water masses the volume of newly formed dense water can be calculated.
The detailed oceanographic objectives are:

- Investigate and identify pathways of recently formed dense shelf water masses.
- Investigate and identify routes of Modified Warm Deep Water on the continental shelf.
- Understand the mechanisms and the time frame, which triggers the intermittent flushing of the dense reservoirs on the shelf.
- Determine composition of recently formed Weddell Sea Bottom Water (WSBW) formed at the Larsen Shelf, i.e. fractions of High Salinity Shelf Water (HSSW) & Glacial Melt Water or Ice Shelf Water (ISW) & other ambient water by the use of tracer measurements (stable helium and neon, and transient CFCs).
- Estimate formation rates of recently formed Weddell Sea Bottom Water (WSBW).
- Improvement of bathymetric charts in an area where water depths are only roughly known.
- Improvement of a Parallel Ice Shelf Model developed in Potsdam to describe the calving and disintegration of ice shelves and to parameterize the ocean melting of grounded and floating ice margins.

Work at sea

Larsen A, B: Oceanographic measurements (CTD) should have a high spatial resolution in order to reconstruct current patterns. One particular aim will be to clarify whether a connection between Larsen A and B beneath a possibly floating ice stripe exists. Also the southern edge of the deep trough underneath the former Larsen B ice shelf is of great interest to investigate the transition zone to the Larsen C ice shelf area further south. Approximately 20 CTD stations from the ship should be sufficient to cover the troughs of the former Larsen A and B and the shelf areas further offshore.

Larsen C: During the ISPOL 2004/2005 expedition a ship independent CTD and water sampler system flown by helicopter was successfully used to enlarge the measuring grid in heavy ice conditions. With this extra CTD system we are able to measure profiles up to 2000 m depth in a range of 60 nm around the ship with the same accuracy as on board the ship. Therefore it should be possible to design a station grid of hydrographic stations on both sides of the outflowing cold and dense plume following the depression in the southwest corner in front of the Larsen C ice shelf.

This depression is slightly shown on bathymetry charts by (Thoma et al 2006, Lange et al 2006) even though the exact bathymetry is not known in this area. In total 30 CTD casts from the ship or with the helicopter CTD should be sufficient.

Data policy and storage

All oceanographic data sets will be calibrated on board or immediately after return at the institute and will then be stored in the PANGAEA data base for public use.

References

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Gilbert R, Domack EW, Camerlenghi A (2003). Deglacial history of the Greenpeace Trough: ice sheet to ice shelf transition in the northwestern Weddell Sea. In: Antarctic Peninsula climate variability, Domack EW, Leventer A, Burnett A, Bindschadler R, Convey P, Kirby M (eds.), Antarctic Research Series, 79, AGU, Washington DC, 195–204.

Thoma M, Jenkins A, Holland DM, Jacobs SS (2008). Modelling Circumpolar Deep Water intrusions on the Amundsen Sea continental shelf, Antarctica, Geophysical Research Letters, 35, doi:10.1029/2008GL034939.

3.2 Observation of stable noble gas isotopes (^{3}He, ^{4}He, Ne) and transient tracers (CFCs)

O. Huhn, M. Vogt, T. Hannemann (UHB-IUP)

Objectives

Useful tools to identify glacial melt water or Ice Shelf Water are the low-solubility noble gases helium (He) and neon (Ne). Atmospheric air with a constant composition of these noble gases is trapped in the ice matrix during formation of the meteoric ice. Due to the enhanced hydrostatic pressure at the base, these inert gases are completely dissolved in the water, when the shelf ice is melting from below. This leads to an excess of Δ^4He=1060 % and ΔNe=770 % in pure glacial melt water (Δ stands for excess over an air-water solubility

equilibrium). With an accuracy of 0.5 % for ^{4}He measurements, melt water fractions of 0.05 % are detectable by this method.

Particularly at mid-ocean ridges in the Pacific, additional (primordial) ^{3}He (and less ^{4}He) is released into the deep water, resulting in an enhanced ^{3}He/^{4}He ratio of about 8 times the atmospheric ratio. These waters contribute to Circumpolar Deep Water, and hence to Warm Deep Water, which then has a maximum ^{3}He/^{4}He ratio. Neon provides complementary information, since it has, in contrast to helium, no internal sources other than glacial melt water. Combination of these tracers, together with potential temperature and salinity, allow applying a multiparametric water mass analysis to quantify the source water composition of the observed water masses. This enables us in particular to assess the quantitative spatial distribution of the contribution of glacial melt water, the location, the paths and rates of basal melt water induced bottom water formation and basal melt water rates.

Since the ocean surface's ^{3}He/^{4}He ratio is usually in equilibrium with the atmospheric one, observed mixed layer dis-equilibriums can be inferred to assess upwelling velocities and rates from water from below.

Chlorofluorocarbons (here CFC-11 and CFC-12) are gaseous, anthropogenic tracers that enter the ocean mixed layer by gas exchange with the atmosphere. The evolution of these transient or age tracers in the ocean interior is determined by their temporal evolution in the atmosphere and subsequently by advection and mixing processes in deep and bottom water (deep and bottom water formation). They allow estimating transit times of recently ventilated waters in the ocean interior, depicting the ventilation or renewal time scales of these water masses.

Work at sea

We intend to obtain about 700 water samples for noble gas isotopes and 1000 water samples for CFCs from the ship deployed full depth profiling CTD and water sample system. Additionally, we are going to take water samples for noble gas isotopes from the helicopter deployed CTD system. Since this system's water sample capability is limited, we will only take 2 - 3 samples from near the bottom and the surface.
The water samples for the noble gas isotopes are drawn from the CTD water sample systems and will be stored in gas tight copper tubes. The samples will be analysed later in the IUP Bremen mass spectrometry lab. After gas extraction, the samples will be analysed with a special sector field and quadruple mass spectrometer system. Additionally, we will take water samples with a new developed system, in which previously evacuated glass ampoules are filled half with sea water and then are flame sealed. The advantage of that new system is that nor further gas extraction in the home lab is needed, but the noble gases expanded into the headspace of the glass ampoules can be measured directly with the mass spectrometric system.

Water samples for CFC measurements will be stored from the ship deployed water samplers into glass ampoules and will be sealed off after a CFC free headspace of pure nitrogen has been applied. In the IUP Bremen CFC lab the measurement uses a purge and trap sample pre-treatment followed by gas chromatographic (GC) separation on a capillary column and electron capture detection (ECD).

Data policy and storage

Due to shipping home, the extensive treatment of the samples in the IUP home labs, and an accurate quality control, the results of the measurements are expected not before the end of

2013 or early 2014. The data will be made available to our colleagues as soon as possible. Once published, we will store them in the PANGAEA data base.

4. ANTARCTIC KRILL POPULATION DYNAMICS IN THE NORTH-WESTERN WEDDELL SEA (CCAMLR)

V. Siegel, A. Elsheimer, C. Fromm, U.Mühlenhardt-Siegel (FS-DZMB) R. Driscoll (vTI-SF/NOAA-SWFSC)

Objectives

The general objectives of the krill and zooplankton study will be to conduct a net-based, oceanographic krill survey in the north-western Weddell Sea. The project introduces a krill and zooplankton study in outflow area of the western Weddell Sea into the Scotia Sea east of the Antarctic Peninsula. The focus of the studies relates to quantitative aspects of krill biology, distribution, biomass, phenology and demography (size, age, maturity composition) and population dynamics (growth, spawning timing, larval development, recruitment). Furthermore, aspects relate to zooplankton species.

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The first focus of the study is the relationship between the biology of krill species (especially *Euphausia superba* and *E. crystallorophias*) as well as other zooplankton species and the environmental conditions, sea-ice and physical oceanography of the water column. Objectives will be to collect and process physical oceanographic data in order to identify hydrographic characteristics and map different types of water masses experienced during the surveys. These data may be used to describe the physical circumstances associated with various biological observations.

The Rectangular Midwater Trawl (RMT) net sampling programme will collect essential krill demographic information, which includes length, sex ratio, maturity stage composition, reproductive condition as well as distribution, abundance and developmental composition of the larval stages. Information useful for determining the relationships between krill distribution patterns and ambient environmental conditions will be derived from net samples taken at pre-fixed station locations. The investigation will also consider a potential habitat change in the krill population and zooplankton composition as a consequence of long-term changes in sea-ice conditions in the Antarctic Peninsula region. The study will also allow the investigation of the summer spawning condition of krill species (which usually occurs in January-February) and the dispersion of more northern zooplankton species into the area under seasonal warming conditions. Areas to the north will be surveyed synoptically by vessels from the US and Norway. The study is also planned as a pre-study to collect benchmark data to be compared with the follow-up winter cruise of *Polarstern* in 2013.

The primary objectives of the bioacoustic survey will be to map the meso-scale dispersion of Antarctic krill (*Euphausia superba*) in the north-western Weddell Sea and to determine their association with water mass boundaries, spatial patterns of primary productivity, and bathymetry.

Work at sea

The large RMT plankton net and CTD will be deployed at 44 stations along four transects (Fig. 4.1). Continuous recording of krill acoustic targets will be conducted by the SIMRAD EK 60 multi-frequency echo-sounder. This survey is part of an international synoptic acoustic and net sampling programme for Antarctic krill in adjacent areas; the USA will study the

areas around Elephant Island and the South Shetland Islands, Norway around the South Orkney Islands, and Germany in the north-western outflow region of the Weddell Sea.

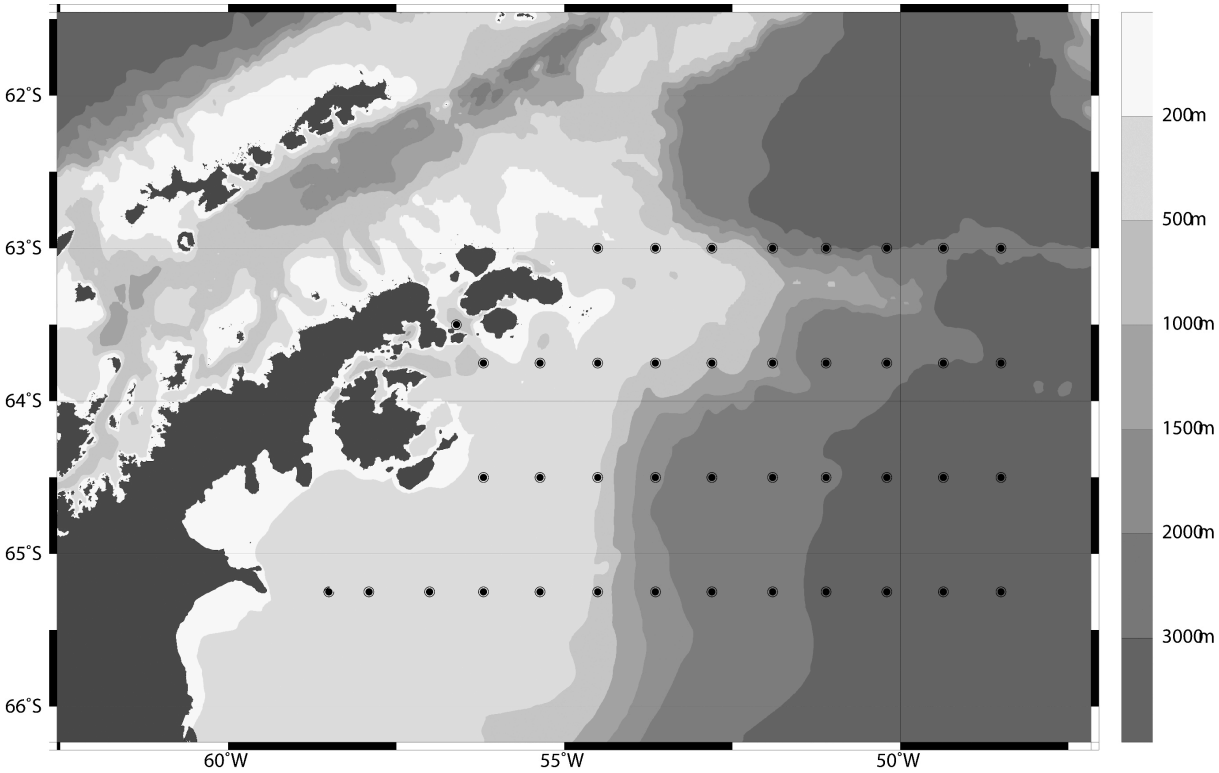

Fig. 4.1 Station chart of the RMT1+8 net sampling and CTD casts east of the Antarctic Peninsula in January 2013

Four West-East transects will be carried out along 63° S, 63°45'°S, 64°30'°S, 65°15°S, the maximum length of transect is 200 miles, distance between transects is 45 miles. Each transect will consist of 8 - 14 station with a spatial distance of 20 nautical miles, thus 44 stations in total. During the survey, a standard RMT1+8 plankton net will be deployed. The mesh size of the larger 8 m^2 net is 4.5 mm and of the smaller 1 m^2 net is 0.33 mm, respectively (to collect adult and larval krill simultaneously). The net is equipped with a calibrated flow meter and an online depth recorder. The data will allow a continuous check of the track of the net as well as a later estimate of the filtered water volume. Primary sample processing will be conducted in the wet laboratory. Antarctic krill will be separated from the catch and enumerated; salps will be separated, counted and measured. Other adult and larval euphausiids will be identified to species level, staged to developmental stages and preserved. Sub-samples of *Euphausia superba* from each tow will be processed in the onboard laboratory to determine length distribution of krill, weight, maturity stage, sex ratio and reproductive condition.

At each of the stations the RMT deployment will be followed by a CTD cast collecting data on temperature, salinity and fluorescence. Water samples will be obtained at a series of standard depths. Measurements of the salinity of the water samples will be determined using a salinometer to calibrate electronic instruments on the CTD.

Expected results

The area east of the Antarctic Peninsula is known as the outflow region of the Weddell Gyre transporting water from the western Indian Ocean - Lazarev Sea via the Eastern Weddell Sea into the Scotia Sea. The Scotia Sea has long been known for its high krill biomass, which does not only satisfy a huge demand of predators, but also allows a commercial krill fishery. The discussion on the Weddell drift and the origin of krill in the Scotia Sea is still ongoing and field data are of great importance.

Currently drift models do not adequately represent the current system of the Weddell Gyre east of the Antarctic Peninsula, thus they do not distinguish clearly between the effects of the Bellingshausen Sea and Weddell Sea origin of the water masses. Genetic studies have not yet been able to separate different krill population from the circum-Antarctic distribution range. The present study would offer a unique opportunity to collect fundamental oceanographic as well as biological data, which could help to interpret the diverging hypotheses on the drift and origin of krill along the Weddell Gyre. The existence of two populations and its potential mixing in the Scotia Sea is not only of basic scientific interest, it also will affect the management strategy for the krill fishery, if two stocks have to be considered with different life histories, growth rates, recruitment and survival rates.

Data from an area, which is often covered by multi-year sea-ice could be regarded as an extreme habitat for krill and help to demonstrate the plasticity or the margins of the population survival. Results would also allow a flexible use of input parameters for the potential yield model used in CCAMLR to estimate the maximum catch limit for a krill fishery. Currently a uniform set of parameters is used for all sub-regions around the continent, because no information on geographical differences in population dynamic parameters is available.

CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources) has developed Small Scale Management Units (SSMU) along the Antarctic Peninsula region to allow a sustainable management of the krill resources in this area where most of the commercial fishery takes place. The SSMU have been established to split the total allowable catch of a Statistical Area limit into smaller portions to avoid local depletion of the krill stock and serious overlap of the fishery with land-based predators, such as penguins and seals. For the majority of the SSMU relatively good survey data exist to feed the model and estimate krill biomass and calculate the proportionate precautionary krill catch. One of the SSMU that has not yet been studied is the region just east of the Antarctic Peninsula between 63° and 66°S (AP-east). Currently data from this area simply do not exist. The German contribution will fill in a gap first by logistic capability and secondly by supporting completely new data from an area not yet studied for its krill and zooplankton populations.

Data management

Representative subsamples from the RMT catches will be preserved in 4 % formalin seawater solution and will be stored at the Institut für Seefischerei in Hamburg (vTI-SF). A copy of the survey data set will be submitted to the CCAMLR secretariat data base in Hobart. CTD and acoustic raw data from the SIMRAD EK 60 echosounder will be stored in the data base of the Institute für Seefischerei in Hamburg and the PANGAEA data base of the AWI in Bremerhaven. Access to all samples and data will be possible on request after processing and corrections have been finalized, but not later than January 2014; requests should include a brief description of the objectives of the work planned.

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Rackete, Carola	3.Offc.
Hering, Igor	2.Offc.
Spilok, Norbert	Doctor
Koch, Georg	R.Offc.
Kotnik, Herbert	2.Eng.
Schnürch, Helmut	2.Eng.
Westphal, Henning	2.Eng.
Brehme, Andreas	Elec.Tech.
Riess, Felix	Electron.
Dimmler, Werner	Electron.
Winter, Andreas	Electron.
Feiertag, Thomas	Electron.
Clasen, Burkhard	Boatsw.
Neisner,Winfried	Carpenter
Clasen, Nils	A.B.
Burzan, G.-Ekkehard	A.B.
Schröder, Norbert	A.B.
Moser, Siegfried	A.B.
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Kretzschmar, Uwe	A.B.
Kreis, Reinhard	A.B.
Schröter, Rene	A.B.
NN	A.B.
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Plehn, Markus	Mot-man
Fritz, Günter	Mot-man
Krösche, Eckard	Mot-man
Dinse, Horst	Mot-man
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Völske, Thomas	Cooksmate
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Hennig, Christina	Stwdss/KS
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